SEE FOLLOWING NOTE

☐ **PLEASE NOTE THAT PAGINATION APPEARS IRREGULAR, BUT THE TEXT IS COMPLETE.**

☑ THIS DOCUMENT MAY BE INCOMPLETE OR PARTLY ILLEGIBLE. NO BETTER COPIES ARE AVAILABLE, MICROMEDIA HAS DECIDED TO FILM THE DOCUMENT FOR ARCHIVAL PURPOSES

VOIR NOTE CI-APRÉS

☐ VEUILLEZ NOTER QUE LA PAGINATION EST ERRONEÉ MAIS LE TEXTE EST INTÉGRAL.

☑ CE DOCUMENT N'EST PAS COMPLETE ET/OU EST EN PARTIE ILLISIBLE. MEILLEURS ÇOPIES N'EXISTENT PAS DONC MICROMEDIA A DECIDE DE FILMER LE DOCUMENT POUR LES BESOINS DES ARCHIVES.

Micromedia
ProQuest

20 Victoria Street
Toronto, Ontario M5C 2N8
tel: (416) 362-5211
toll free: 1-800-387-2689
fax: (416) 362-6161
web: www.micromedia.ca

Ministry of Forests, 518 Lake Street, Nelson, British Columbia V1L 4C6

ASSESSMENT AND CHARACTERIZATION OF OLD-GROWTH STANDS IN THE NELSON FOREST REGION

FINAL REPORT FOR E. P. 1175.01

H. J. Quesnel, Ph.D., P.Ag., R.P.Bio.

Technical Report TR - 013

forest sciences

NELSON FOREST REGION

634.909
711
BCMF
RES
NE
TR-013
c.2

Ecology • Geomorphology • Hydrology • Pedology • Silviculture • Silvicultural Systems

106-06419/

634.909711 BCMF RES NA TR
Quesnel, H.J.
Assessment and
characterization of
old-growth stands in the

mq53333

MINISTRY OF FORESTS LIBRARY
PO BOX 9523 STN PROV GOVT
VICTORIA BC V8W 9C2

ASSESSMENT AND CHARACTERIZATION OF OLD-GROWTH STANDS IN THE NELSON FOREST REGION

FINAL REPORT FOR E. P. 1175.01

H. J. Quesnel, Ph.D., P.Ag., R.P.Bio.

Technical Report TR - 013

LIBRARY
MINISTRY OF FORESTS
PO BOX 9523 STN PROV GOVT
VICTORIA BC V8W 9C2

Forest Sciences Section
Ministry of Forests
518 Lake Street
Nelson, B.C.
V1L 4C6

February, 1996

EXECUTIVE SUMMARY

This study uses mensuration data to characterize old-growth stands. The biogeoclimatic ecosystem classification (BEC) sampling program provided data for almost 400 plots greater than 140 years old in the Nelson Forest Region (NFR). Summary statistics for this data set were limited because there were no plots in the Ponderosa Pine (PP) zone, and a few site series from other zones either lacked data or only had a few plots. In general, the data set provided good coverage for most of the ecological units; useful old-growth criteria could be developed to the site series level for many variants, and where site specific criteria were not possible, general zone level criteria could be suggested. Zonal criteria based on the density of trees >50 cm dbh for the PP and Interior Douglas-fir (IDF) zones would be 25 and 17 stems/ha, respectively. For the Interior Cedar-Hemlock (ICH) zone, the density for trees of the same minimal diameter would yield a zonal criterion of 36 stems/ha for the drier variants and 60 stems/ha for the wetter variants. Zonal criteria based on the density of trees >30 cm dbh for the Engelmann Spruce-Subalpine Fir (ESSF) zone, and for the Montane Spruce (MS) zone with stands dominated by lodgepole pine, would be 41 and 75 stems/ha, respectively. Density of trees >40 cm dbh also yield zonal criterion for the IDF zone, and for the MS zone with stands not dominated by lodgepole pine, of 58 and 39 stems/ha, respectively. Summaries of the BEC plot data also provide baseline information on tree class and tree species composition.

Twenty-six stands were sampled in detail for BEC units identified by a geographical information system (GIS) as having limited areas of forests >140 years old. Twenty-two of these stands were rated as rare old-growth stands. The criteria used included age and density of larger living or dead trees. Four additional stands had detailed sampling but did not meet the minimal screening criteria. Thirty-eight stands were examined but not sampled because the reconnaissance indicated a lack of old-growth attributes, the BEC unit was not identified as rare by the GIS project, limited access or time prevented detailed sampling, or only helicopter viewing was possible. Notes and summary information were compiled for both the stands with detailed sampling and other stands examined for rare old-growth.

Management application of the old-growth criteria developed in this study is briefly discussed. Summary statistics for the BEC data sets can be used as standards for evaluating and mapping potential old-growth stands. These standards could also be used for setting management targets where old-growth recruitment is required.

ACKNOWLEDGEMENTS

Several reviewers have provided comments and suggestions which have greatly improved this document. The initial working plan was reviewed for general ecological ideas and field methods by Andy MacKinnon, Del Meidinger, and John Parminter, Research Branch, Victoria, and Dr. Phil Burton, University of British Columbia. Improvement and clarification of statistical methods resulted from the working plan review and advice for subsequent data analysis by Vera Sit, Statistician, Ministry of Forests, Research Branch, Victoria.

The final report has benefited from the critical review of Pat Green and John Joy, USDA Forest Service. The report was also thoroughly reviewed by Andy MacKinnon, Research Branch, Ministry of Forests, Victoria, and Tom Braumandl, Research Section, Ministry of Forests, Nelson.

For the rare old-growth stands, field data was collected by Gareth Kernaghan, JMJ Holdings Inc., George Wilson and Chris Steeger, Pandion Consultants, Anette Thingsted, Victoria, and the author. Data entry was aided by Jennifer Pollard, Victoria. Tom Braumandl, Research Ecologist, NFR, provided background information and data sets for the biogeoclimatic ecosystem classification program. Chris Thompson, Research Silviculturist, NFR, provided timely assistance in the data analysis procedures. Rick Logan and Ivana Velisek, NFR, drafted Figures 1–4.

An english edit of the final report was provided by Edward Wagstaff, Shawnigan Lake. Lorne Evin and Michele Mason, Ministry of Forests, Nelson, aided production of the report.

Finally, John Pollack, Forest Sciences Officer, NFR, should be acknowledged for providing administrative and technical support for this project.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii
ACKNOWLEDGEMENTS iii
1 INTRODUCTION 1
1.1 Old-Growth Biology And Concepts 1
1.2 Old-Growth Identification In The Nelson Forest Region 7
2 STUDY AREAS AND PLOT LOCATIONS 9
2.1 Biogeoclimatic Ecosystem Classification Sampling 9
2.2 Variants With Potentially Rare Old Growth 9
3 PLOT LAYOUT AND MEASUREMENTS 13
3.1 Biogeoclimatic Ecosystem Classification Sampling 13
3.2 Variants With Potentially Rare Old Growth 14
4 DATA ANALYSIS 16
4.1 Biogeoclimatic Ecosystem Classification Sampling 16
4.2 Variants With Potentially Rare Old Growth 16
4.3 Comparing Potentially Rare Old-Growth Stands To BEC Standards 17
5 RESULTS AND DISCUSSION 18
5.1 Ecological Classification Sampling And Data Summary 18
5.1.1 ESSF Zone 20
5.1.2 ICH Zone 31
5.1.3 IDF Zone 39
5.1.4 MS Zone 44
5.1.5 PP Zone 49
5.2 Stands Sampled In Variants With Rare, Older-Age Classes Which Are Old-Growth? 51
5.3 Management Applications 62
6 SUMMARY AND CONCLUSIONS 64
7 REFERENCES 137

APPENDICES

1 Subzone/variant names, tree species, and elevation ranges for biogeoclimatic units 66
2 BEC stands greater than 140 years old: frequency of tree species by site series within variants 69
3 BEC stands greater than 140 years old: frequency of tree classes by site series within variants 83
4 Site notes 89
5 Site characteristics for additional stands examined but not sampled for old growth 110
6 Sites sampled for old growth: disturbance agents, wildlife observations, humus depths, suppressed trees, and general comments 114
7 Sites sampled for old growth: tree class frequency for each site 119
8 Sites sampled for old growth: wildlife tree class frequency for each site 122
9 Sites sampled for old growth: tree species frequency for each site 125
10 Sites sampled for old growth: summary statistics for tree germinants on each site 132

FIGURES

1 Stand stratification in rare old-growth stands 11
2 Locating plots when sampling rare old-growth stands 12
3 Plot layout for sampling rare old-growth stands 15
4 Plot locations 19
5 Stand ages by site series for the ESSFdc1, ESSFdk, and ESSFdkp variants 25
6 Stand ages by site series for the ESSFvc, ESSFvcp, ESSFwc1, and ESSFwc2 variants 26
7 Stand ages by site series for the ESSFwc4, ESSFwcp, and ESSFwm variants 27
8 Densities of large dimension trees by site series in the ESSFdc1, ESSFdk, and ESSFdkp variants 28
9 Densities of large dimension trees by site series in the ESSFvc, ESSFvcp, ESSFwc1, and ESSFwc2 variants 29
10 Densities of large dimension trees by site series in the ESSFwc4, ESSFwcp, and ESSFwm variants 30
11 Stand ages by site series for the ICHdw, ICHmk1, and ICHmw1 variants 35
12 Stand ages by site series for the ICHmw2, ICHvk1, and ICHwk1 variants 36
13 Densities of large dimension trees by site series in the ICHdw, ICHmk1, and ICHmw1 variants 37

14 Densities of large dimension trees by site series in the ICHmw2, ICHvk1, and ICHwk1 variants 38
15 Stand ages by site series for the IDFdm1, IDFdm2, and IDFun variants 42
16 Densities of large dimension trees by site series in the IDFdm1, IDFdm2, and IDFun variants 43
17 Stand ages by site series for the MSdk and MSdm1 variants 47
18 Densities of large dimension trees by site series in the MSdk and MSdm1 variants 48

TABLES

1 BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the ESSF zone 22
2 BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the ICH zone 33
3 BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the IDF zone 41
4 BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the MS zone 46
5 Site characteristics of stands sampled for old growth 52
6 Sites sampled for old growth: summary statistics for age, densities, and basal area for each site 56
7 Rare old-growth stands that meet standards for Nelson Forest Region 58

1 INTRODUCTION

1.1 Old-Growth Biology And Concepts

The final report for the Old-Growth Strategy of British Columbia defined old-growth forests as "natural stands of old and young trees and their associated plants, animals, and ecological relationships which have remained essentially undisturbed by human activities." (B.C. Min. For. 1992a). The strategy further notes that "this general definition requires extensive refinement to reflect ecological diversity within British Columbia ... and [to reflect] specific structural features which can be used to characterize old growth stands for purposes of inventory and management." This implies that the stand should reflect the natural disturbance agents in an area prior to significant impact by technological humans. Natural disturbance agents will influence tree species composition, tree density and distribution in a stand, tree dimensions, snag frequency, and other structural attributes. Thus, old growth should reflect fire-climax in areas with high-frequency fire disturbance or should typify climatic climax conditions, as defined in Mueller-Dombois and Ellenberg (1974), in areas dominated by low-frequency fire or other stand initiating disturbances. Long-lived seral species, such as coastal Douglas-fir, would also qualify as old growth (Franklin et al. 1981).

Old-growth retention and management is an important forest management issue (B.C. Min. For. 1992a). Requirements for old growth have been recognized or specified for management plans in the Okanagan Timber Supply Area (B.C. Min. For.1992b), Upper Carmanah Valley (Carmanah Valley Forest Management Advisory Committee 1992), and Prince Rupert Forest Region (Steventon 1994). A conservation and management plan has been implemented for the Robson Valley Forest District (B.C. Min. For. 1992c), which also includes a complete inventory of the major old-growth areas remaining in the forest district and designation of these areas for special management. Old growth is an important component of biological diversity (biodiversity) (Pojar 1991). Areal requirements for old growth are specified in coastal biodiversity guidelines (Coastal Biodiversity Guidelines Committee 1992). Similar requirements exist in the biodiversity guidebook for the Forest Practices Code (B.C. Min. For. and BC Environ. 1995).

The ecology of old growth in the Douglas-fir (*Pseudotsuga menziesii*) region of coastal Washington and Oregon has been studied by Dr. J. Franklin and his colleagues (e.g., Franklin et al. 1981, Spies 1990). These studies have documented many important compositional, structural, and functional attributes of these forests, including large trees,

large snags, large downed wood on land, and woody debris in watercourses. Although these studies provide a good basis for coastal Douglas-fir, they have only general application to most of British Columbia (B.C. Min. For., Res. Br. 1990). British Columbia has 12 forested zones with major differences in climate, topography, tree species, and wildlife (Meidinger and Pojar 1991). These yield many ecosystems and forest types, including old growth, that have significant differences from coastal Douglas-fir.

Past research on stands that are most comparable to old growth in the NFR include several studies in eastern Washington, Idaho, Montana, and the Rocky Mountains on both sides of the international border. These studies have characterized several old-growth forests. Stands comparable to the Engelmann Spruce–Subalpine Fir (ESSF) forests have been studied in Alberta and Colorado. Subalpine forests were found to have old-growth stands of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) that represent a balance between greater fecundity of the subalpine fir and lower mortality of Engelmann spruce (Veblen 1986). In dry forests with these species in the Rockies of southern Alberta, fire suppression may eventually yield forests that do not have the structural attributes desired for old-growth forests (Day 1972). These forests would be dominated by high-density, subalpine fir and would have a lower density of larger Engelmann spruce. The latter species was considered more desirable for old-growth forests in southern Alberta.

Old-growth stands in the Interior Cedar–Hemlock (ICH) Zone of British Columbia were recently inventoried for lichens by Goward (1994). Goward sampled several dozen stands in this zone. Several stands were located just north of the NFR. Floristically, these stands should be very similar if not identical to stands in the wetter ICH subzones of the NFR. Goward describes several very old stands in the ICHvk as "antique forests." The lichen flora in these antique forests contained several old-growth-dependent epiphytic macrolichens that Goward infers are the result of long-term environmental continuity. Possibly, the wet, cool nature of this subzone and strong topographic relief have created conditions where remnant forests have not been subjected to stand-initiating disturbances, such as fire, for several centuries. Old-growth stands with tree species and structural attributes similar to the ICH zone have also been studied in states just south of British Columbia. Old-growth cedar–hemlock stands in Montana appear to be climax stands that develop after fire (Habeck 1968). The post-fire sequence is dense stands of lodgepole pine (*Pinus contorta*), a mid-seral stage with stands of western white pine (*Pinus monticola*) and Douglas-fir, and a climax stage with western hemlock (*Tsuga*

heterophylla) and minor western redcedar (*Thuja plicata*). Other studies on these cedar–hemlock sites in northeast Washington and Idaho have found that old growth requires 200 years without a stand-replacing disturbance to develop, that western white pine will only occur as a canopy species in the later seral stages, and that succession is accelerated by blister rust and pine-beetle-induced mortality of this pine species (Moeur 1992; Turner and Franz 1985).

Stands similar to old growth in the Interior Douglas-fir (IDF) Zone have been described in Montana, eastern Oregon, and eastern Washington by Tesch (1981), Habeck (1990), and Hessburg et al. (1994). Tesch (1981) found that two old-growth stands of Douglas-fir were climax stands requiring 240 or more years to develop after a stand-replacing fire. In a review article, Habeck (1990) describes old-growth stands of ponderosa pine and western larch (*Larix occidentalis*) in western Montana as fire-dependent. These stands require low-level ground fires every few years to a few decades to maintain the desired stand structure. Fire suppression for several decades yields stands with greater fuel load of other species, such as Douglas-fir. The result is a greater probability of a catastrophic stand-replacing fire and total loss of desired old-growth stand attributes. The influence of technological humans on forest health agents in eastern Oregon and Washington was the focus of a review by the Eastside Forest Ecosytem Health Assessment (Hessburg et al. 1994). Hessburg et al. (1994) note that the selective harvesting of high-value western larch and ponderosa pine combined with fire suppression has accelerated conversion of open, parklike stands to higher density stands of late seral-stage Douglas-fir and grand fir (*Abies grandis*). These latter species are more susceptible to insects and diseases. These results support the idea of the important role of fire in maintaining desired stand attributes as suggested by Habeck. Hessburg et al. (1994) also assess historical changes in stands comparable to many of the variants in the NFR.

A stand type similar to old-growth stands in the Ponderosa Pine (PP) zone is described for Glacier National Park, Montana (Lunan and Habeck 1973). The authors conclude that stand attributes in this old-growth ponderosa pine (*Pinus ponderosa*) would require periodic, low-level ground fire to maintain the desired old-growth structures. This type of disturbance provides germination opportunites for the pine, reduces the fuel load, which mimimizes the risk of catastrophic fire, and reduces invasion by Douglas-fir and Engelmann spruce.

The role of fire and other natural disturbances in maintaining old-growth stands in the NFR must be recognized and included in management plans for maintaining the desired

landscape and stand attributes. The influence of fire suppression and timber harvesting on the areal extent of an old-growth type and on changes in stand structure must also be recognized. These processes have yielded current stands that probably differ from historic ecosystems in terms of species composition and stand density as noted above.

The fire regime in the Rocky Mountains contrasts with coastal Douglas-fir, where the fire regime is characterized by less frequent but more intense fires (Hemstrom and Franklin 1982). The natural fire regime in the Rocky Mountains appears to be frequent non-lethal underburns every few years to a decade, with stand-replacing fires occurring at intervals of several decades to a few hundred years (Arno 1980; Barrett et al. 1991). This overview of the fire regime best reflects the dry, low-to mid-elevation forests of the NFR and would not properly describe all variants[1] in high elevation or wetter areas of the region. The fire regime in the NFR differ between variants as these reflect differences in climatic regime (Braumandl and Curran 1992). Low-intensity, more frequent underburning typifies the PP zone, the IDF zone, and portions of the drier variants in the ICH zone. Stands in the Montane Spruce (MS) Zone, the ESSF zone, and most of the ICH zone have had greater influence from stand-replacing fires of lower frequency. The result is lower density, more open stands in the drier subzones/variants, higher-density stands in the wetter units, and extensive stands of lodgepole pine reflecting stand-replacing fires in the MS zone (Braumandl and Curran 1992). Fire frequencies and intensities are tabulated by biogeoclimatic ecosystem classification (BEC) zones (B.C. Min. For., Res. Br. 1990). For zones occurring in the NFR, the PP zone has surface fires with an average fire return interval of approximately 10 years and a range of 4–25 years. In contrast, the ESSF zone has more intensive surface plus crown fires with an average return interval of 250 years. A maximum return interval of 500 years occurs in the wettest variants of this higher-elevation zone. The natural fire regime in the Rocky Mountain area combined with the shorter growing season probably results in old-growth stands with smaller live trees, smaller snags, and less accumulated decaying wood than for coastal Douglas-fir as described by Franklin et al. (1981). In the wetter variants of the NFR, the lower fire frequency results in greater disturbance due to insects, disease, and windthrow between catastrophic fire events. The forest health agents operating in these variants are listed in Braumandl and Curran (1992) and B.C. Min. For., Res. Br. (1990).

---

[1] In this report, variant is used as a general classification term to simplify the discussion. Variant will also be used to describe subzones where the subzone has not been subdivided into more than one variant. Biogeoclimatic units for the Nelson Forest Region, including subzones and variants, are defined in Braumandl and Curran (1992).

Studies on ecological processes have generally considered old growth from two main perspectives. The first perspective is the stand dynamics approach of Oliver and Larson (1990). Old growth is considered the last stage of stand development between disturbances. These stands consist entirely of trees that have developed beneath the canopy of other trees. This indicates that the stand is significantly older than the average disturbance return interval for stand-initiating events. Thus, old growth consists of shade-tolerant, climax tree species. A recent study in the Sub-Boreal Spruce (SBS) Zone of British Columbia fits in the stand dynamics perspective (Kneeshaw 1992). This latter research assumed that old growth occurs when single-tree replacement or gap process is more important than past stand-level disturbance events. This author used a population dynamics approach to study old-growth stands and felt that a useful parameter for identifying these stands was the ratio of basal area of the replacement cohort to basal area of the initial post-disturbance cohort.

The second perspective on old growth focuses on structures rather than stand development processes. Oliver and Larson (1990) also discuss this alternative perspective. They note that structures are more important for wildlife and recreational use than any nominal stage of stand development. They also note that these structures are more a result of species and climates than disturbance regime. As examples, Oliver and Larson note the old-growth stands of conifers from wet, cool, coastal Pacific northwestern climates, and from dry climates of the Rocky Mountains. These stands are the result of long-lived species in a favourable climate that attain large size, yield large snags and down logs, and are slow to decompose. In contrast, stands from areas such as the southeastern United States or the tropics generally have tree species that do not grow as large, dead, organic matter decomposes faster in these stands, and thus the same structural attributes do not develop. Wildlife use associated with structural attributes, such as large trees, snags, coarse woody debris, multiple-layered canopies, and canopy gaps has been the focus of several studies and reviews (Bunnell and Allaye-Chan 1987; Franklin et al. 1981; Harmon et al. 1986; Mannan and Meslow 1984; Maser et al. 1979; Thomas et al. 1979). These studies emphasize that old-growth stands are important for wildlife because of the presence of relatively high concentrations of trees, snags, and woody debris with dimensions that tend to be in the largest size classes found in natural systems. This principle appears to hold for the NFR as demonstrated by a recent study near Kootenay Lake. Steeger and Machmer (1995) found that the majority of wildlife trees used were >40 cm in diameter and at least 15–20 m in height.

While it is of interest from a stand development perspective that an old-growth stand be considered as trees developed under the canopy of other trees, stands reaching this stage may not include many of the structural attributes required by wildlife species. A good example is the old-growth, Douglas-fir stands on the Pacific coast. Many of the important wildlife structures result from large, seral Douglas-fir (Franklin and Hemstrom 1981). Climax stands in these areas would consist of western hemlock and would lack trees, snags, and down wood comparable in size to that formed by Douglas-fir. Closer to the NFR, long-term fire suppression in areas with stands of large ponderosa pine or western larch would likely yield denser stands of smaller Douglas-fir with a greater potential for stand-replacing fires (Habeck 1990). This would increase the probability of losing the large pine and larch trees and snags that are important for wildlife use in these areas. Lack of fire also reduces the frequency of germination conditions needed to retain these two tree species in the stand (Oliver and Ryker 1990; Schmidt and Shearer 1990). Thus, for purposes of retaining attributes that are of value for wildlife and recreation, old growth in this study will be considered in terms of important structural features rather than as a stage in stand development.

The old-growth issue in British Columbia has been the focus of some review papers and a strategy development process. A problem analysis was undertaken by several members of the Ministry of Forests (B.C. Min. For., Res. Br. 1990). This review provided a synthesis of knowledge on old-growth definitions, functions, biodiversity relationships, and management. One objective was to determine the relevancy of old-growth research from the northwestern states and Alaska. The review concluded that while research on old growth in coastal Douglas-fir of Washington and Oregon was relevant in general, specific attributes over many of the BEC zones of British Columbia would vary because of the range of climate, tree species, and physiography. The authors felt that the essential first step in old-growth research was to develop working definitions for describing these forests, particularly for forest types in areas under pressure from harvesting, urbanization, or other development. Working definitions were presented by the Old-Growth Task Force (B.C. Min. For. 1992a). These definitions were based solely on minimum age criteria for various tree species in the forested BEC zones. Separate age criteria were presented for coastal and interior forests. The minimum age for most interior forest types was 150 years with 200 years considered appropriate for a few slower-growing species that occur at higher elevations. Other reviews have stated that definitions of old rowth vary and consist of the following broad groups: economic, mensurational, conceptual/ecological, and spirtual/aesthetic (Hamilton and Pojar 1991; Pojar et al. 1990).

A list of mensurational, structural, functional, and conceptual/ecological attributes relevant to the forested BEC zones of British Columbia has been developed (Pojar 1991; B.C. Min. For., Res. Br. 1990). However, this list dealt with the applicability of these attributes to these BEC zones and was not quantitative. For example, a structural attribute included snags with a density of >25/ha. Density or size for this attribute was not given,and applicability was considered unknown for all BEC zones in the NFR. Thus,more quantitative criteria for old growth are needed for the NFR, and the age criteria from the Old-Growth Task Force (B.C. Min. For. 1992a) should be compared with old-growth stands in the region.

1.2 Old-Growth Identification In The Nelson Forest Region

The government of British Columbia announced on May 6, 1992 the development of a Protected Areas Strategy (PAS) for the province. PAS was to combine several conservation initiatives, including portions of the Old-Growth Strategy (B.C. Min. For. 1992a). One of PAS's objectives was to preserve representative old-growth ecosystems. As part of this process, a Regional Protected Areas Team (RPAT) was formed in Nelson. The Nelson RPAT completed several mapping projects to provide a technical database for the planning process. To meet the requirement for dealing with the old-growth issue, one mapping project addressed this. A geographical information system (GIS) was used to combine forest cover, BEC, and ecosection[2] maps and databases to identify potential old-growth stands in the NFR (Quesnel and Leahy 1993). Age classes 8 + 9 (>140 years old) were identified as potential old-growth stands. Within ecosections, old growth was considered to be relatively rare for BEC units with <10%, or <1000 ha but >10% of the productive forest land in age classes 8 + 9. For various ecosections, the following subzones/variants were identified as having relatively rare old growth:

PPdh1	IDFun	ICHmw2	MSdm1
PPdh2	IDFxh1	ICHmk1	ESSFdk
IDFdm1	ICHdw	ICHxw	ESSFwm
IDFdm2	ICHmw1	MSdk	

[2] Ecosections for the Nelson Forest Region are described in Quesnel and Thiessen (1993). The Ecoregion Classification System for British Columbia is described in Demarchi et al. (1990).

These units are described in Appendix 1. Stands in these variants need to be ground-truthed to verify that they meet old-growth criteria. Verification is needed for several planning processes, including the PAS, Forest Practices Code, and integrated resource management planning. Relative value of the stands for preservation, long-rotation management, or other uses can then be evaluated. The stands should also be assessed to see how well they meet old-growth attributes for BEC zones (B.C. Min. For., Res. Br. 1990) and for comparable old-growth stand types in the United States (e.g., Green et al. 1992). In the NFR, summary statistics for old-growth stands are also needed for site series in all variants. This includes structural attributes, such as tree species, dimensions of large trees, snag characteristics, and volumes of coarse woody debris. Summary statistics for these structural attributes will help refine working definitions for old growth. These statistics will also provide better baseline values for assessing wildlife potential and better target values when managing for old-growth attributes in long-rotation planning. The focus should be on quick-to-measure structural attributes. Finally, follow-up studies should include assessment of vertical and horizontal variation, gap processes, wildlife use, stand history, and stand dynamics.

Ground verification of these stands requires a standard for comparison. The most appropriate data set for developing standards is the plot data from the BEC system. The plot data used to develop the classification covers a range of elevations and aspects. For most site series, the basic management unit in the classification, data was collected from several locations. Thus, standards for comparison were developed by analyzing the mensuration data for the stands >140 years old in the BEC program. Stands that meet this age criteria were considered old growth for this project.

The objectives for this study were:

1. to develop standards for old growth from the BEC data set by analyzing the mensuration data;

2. to determine if potentially rare old-growth stands identified by a GIS project were comparable to regional standards; and

3. to provide operational staff with mensuration standards for old growth within the site series of all variants in the NFR.

2 STUDY AREAS AND PLOT LOCATIONS

2.1 Biogeoclimatic Ecosystem Classification Sampling

Standards for old growth in the NFR were derived from the historic stand data collected for the BEC sampling program. The principles and concepts for the BEC system are described in Pojar et. al. (1987) and Braumandl and Curran (1992). The following is a brief overview of data collection for the BEC sampling program in the NFR. In this region, the ecological sampling program focused on mature and older stands. The forest region was stratified into variants based on air photos, topographic maps, forest cover maps, pre-existing biophysical and soils maps, and reconnaissance traverses by ground vehicles and helicopters. Within variants, stands were selected that represented a range of moisture and nutrient conditions. A sample location was selected where overstory, understory vegetation, and soils were relatively uniform and extensive. Sampling for this classification was undertaken in the NFR from 1977 to 1982 (Braumandl and Curran 1992). Data was collected from 1,288 locations throughout the region. Three hundred and ninety-eight locations had stands >140 years old. Each location has mensuration data that includes tree species, diameters, and tree class or general decay condition. Information on snags and down logs was primarily descriptive and of limited value for comparing sites. Data analysis for old-growth standards was limited to stands >140 years old.

2.2 Variants With Potentially Rare Old Growth

The maps and database report generated by the GIS were used to select stands for sampling potentially rare old growth. Field sampling occurred during 1993 and 1994. Biogeoclimatic units with relatively rare old growth were given top priority. Prior to field sampling, input from Ministry of Forests district staff was used to reject stands with recent disturbance or to select alternative stands, if available. For each stand selected, the most recent aerial photography at 1:20 000 scale or larger was used for stratifying the stand into BEC variants or site series, if necessary, and for locating sample points (Figure 1). Within stands where relatively homogeneous but distinctive areas >140 years old occurred, these areas were broken into separate sampling units. If more than one distinct area of the same site series existed within a stand, only the area closest to access was sampled. More than one BEC unit was sampled for some stands. Prior to locating sample points, the stand

was traversed to verify the map-derived site series and variant classification, to verify the forest cover age class by boring a couple of trees, and to select alternative areas, if required. For each area selected in the stand, a cluster of four sample points was located using pre-selected pathways to cover the majority of the unit (Figure 2). The distance between each point was a random distance between 50 m and 200 m along the pathway. The number of sample points per area within a stand varied between one and five; generally four were sampled. Variations occurred for relatively small stands or for one stand that consisted of three small patches of similar but physically separated forest cover polygons.

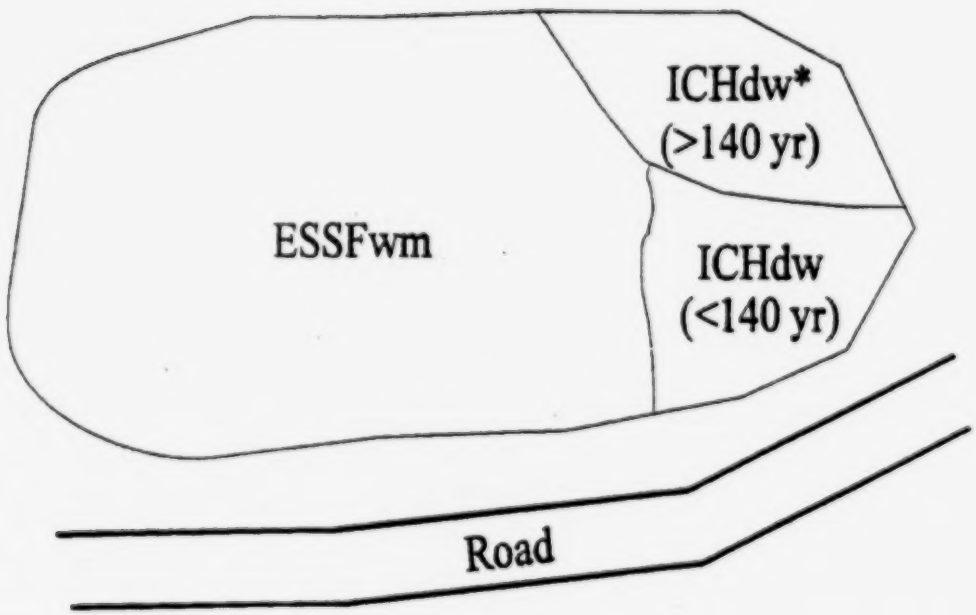

FIGURE 1. Stand stratification in rare old-growth stands[1].

[1] * indicates area to sample. The remainder of stand is too young (<140 yr), inaccessible, or not a variant of interest.

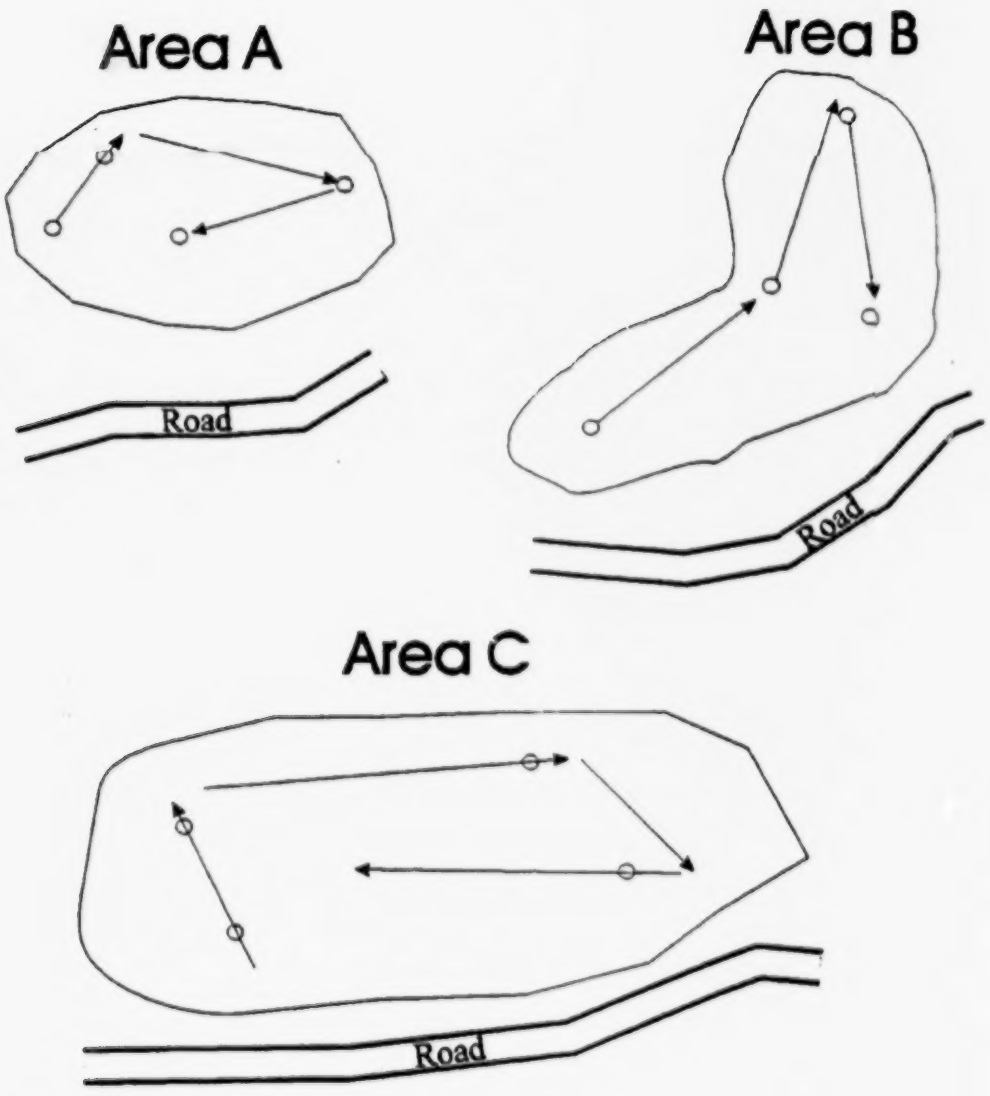

FIGURE 2. Locating plots when sampling rare old-growth stands. Three areas selected from stands for sampling. The arrows indicate pre-selected pathways and the circles indicate sample points at random distances.

3 PLOT LAYOUT AND MEASUREMENTS

3.1 Biogeoclimatic Ecosystem Classification Sampling

The data for the BEC classification was collected several years prior to initiating the current old-growth sampling project on rare stands. Methods for collecting site, soil, vegetation, and mensuration data for the BEC sample program are described in detail in Luttmerding et al. (1990). The following is a brief description of the methods used for collecting BEC data. Within the selected stand, a sample point was selected that was at least 50 m from the edge of the stand type. Site characteristics, soil information, and a vegetation releve were collected at the sample point. For locating mensuration plots, a random bearing was selected and two points—along this bearing in opposite directions—were located at least 7 m from the sample point. At each location for mensuration sampling, a prism sweep was used to collect tree data. For a few stands, only one prism cruise was collected due to time constraints for helicopter access plots, or because of the patchy or uneven nature of the stand type. Data collected included prism basal area factor (BAF), tree species, diameter at breast height (dbh), tree class (B.C. Min. For. 1992d), and tree height for all trees. The minimum tree size was 7.5 cm dbh.

Stand age was determined by boring two trees per species in the dominant/codominant strata and averaging all the measurements, irrespective of species. Technically, this represents the age of the dominant/codominant strata, which may or may not equal stand age determined by detailed analysis of trees from all strata in a stand. For some older trees, age determination was not attempted because of the relatively high degree of rot or missing wood. This yielded an underestimate of stand age because trees sampled had less decay and were probably younger. For some trees with relatively limited quantities of hollow or rotten wood, age was determined for intact wood, and a proportional adjustment for the missing ages was made by assuming the missing wood had the same average increment as the intact wood. It is recognized that this assumption has problems as early tree growth could vary considerably, depending on whether a tree was open grown or suppressed during its early years. Detailed stand reconstruction work might provide clues as to the general nature of a stand during its early development. This approach would likely yield specific data for any individual tree, the necessary data was not collected as part of the BEC sampling program, and the effort was beyond the scope of the current sampling for rare old growth. Post-sampling analysis of the vegetation data, with limited input from site and soil variables, was used to develop the site series

classification within each variant. The BEC classification for the NFR was revised in 1992.

For the old-growth project, stands were selected that were >140 years old at the time of the BEC sampling program. This corresponds to age class 8 and older polygons on forest cover maps, and would meet the minimum age for possible old-growth stands suggested by the Old-Growth Task Force (B.C. Min. For. 1992a). The reader is cautioned that these age class breaks for old growth may differ from those recommended in the biodiversity guidebook of the Forest Practices Code for some natural disturbance types (B.C. Min. For. and BC Environ. 1995). The guidebook was published after the sampling, data analysis, and report writing was completed for this old-growth project.

3.2 Variants With Potentially Rare Old Growth

Fixed area plots were used to collect mensuration data in the stands identified as potentially rare old growth. At each sample point, the boundaries for a 7.98 m fixed radius plot (200 m^2) was flagged (Figure 3). Larger plot size (11.28 m radius) was used for approximately one third of the sites because insufficient trees (B.C. Min. For. 1992d) were obtained with the 7.98 m fixed radius plot. The same plot radius was used for all plots on a site. The following variables were measured or estimated for all live trees >7.5 cm dbh and for dead trees >2 m tall and >7.5 cm dbh: dbh, species, stratum (Luttmerding et al. 1990), and wildlife tree (snag) classification (9 class system as outlined in Backhouse 1993 or Thomas et al. 1979). Tree height and age at 1.3 m were determined for 2 trees/species in the dominant/codominant stratum (Luttmerding et al. 1990). For stands with >3 species in this stratum, only 1 tree/species was aged. Stand age was calculated as the average for all trees aged. As for the BEC plot data, this age is more correctly the age of the dominant/codominant layer. For trees with rotten centres, age was determined for intact wood, width of missing wood was estimated, and missing years were conservatively added, based on average increment of intact wood. A smaller 2.52 m fixed radius (20 m^2) subplot was located with the same plot centre as the main plot. This subplot was used to measure dbh and species for live trees <7.5 cm and >1.3 m tall, and for counting, by species, trees less than 1.3 m tall. Trees suffering suppression were noted.

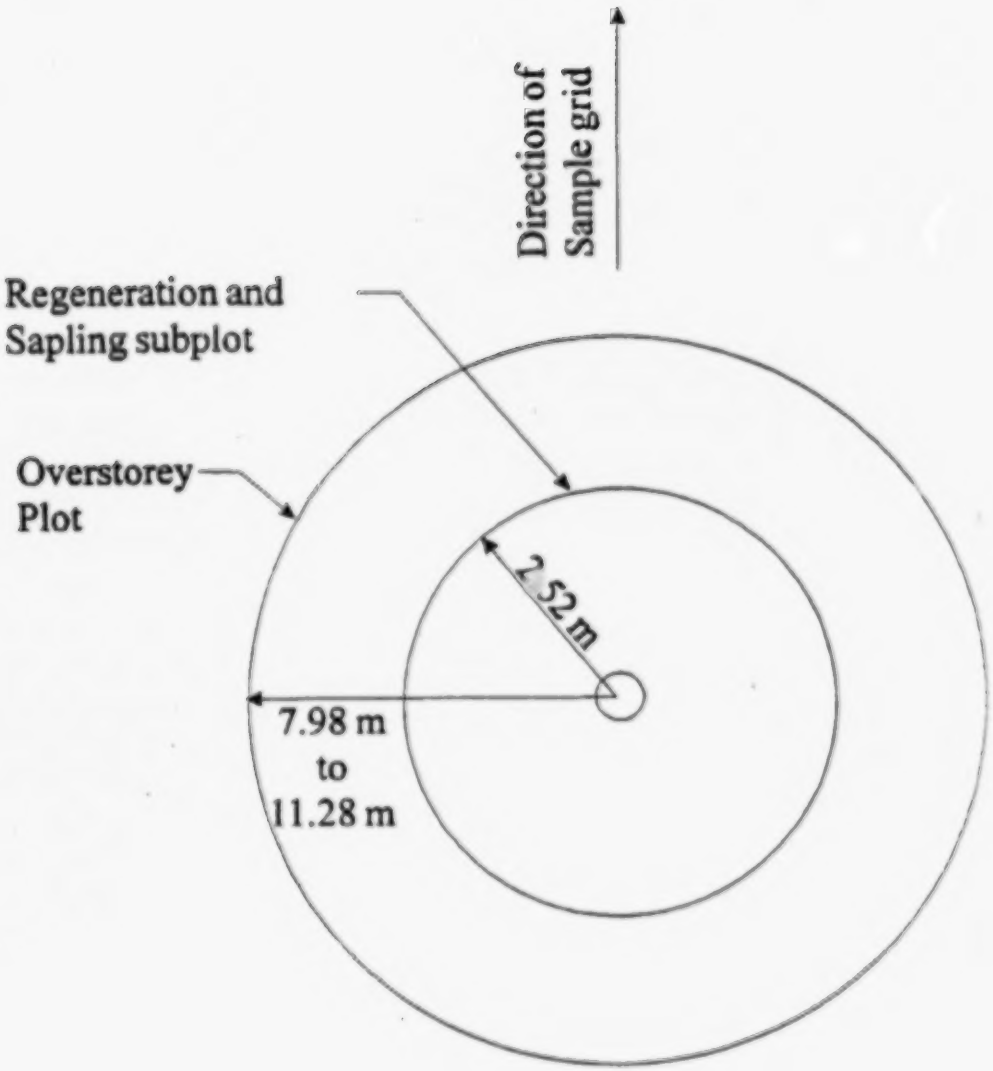

FIGURE 3. Plot layout for sampling rare old-growth stands.

Additional site data collected included: slope, aspect, elevation, depth of forest floor, landform, and map co-ordinates (latitude/longitude). Site series was determined using Braumandl and Curran (1992). The number of main canopy layers was recorded and gaps were noted as present or absent in the stand. Evidence for disturbance (fire, disease, insects, windthrow) and wildlife use (cavities, nests, animal pellets) were recorded.

4 DATA ANALYSIS

4.1 Biogeoclimatic Ecosystem Classification Sampling

Stand age was calculated by averaging the age for all dominant and codominant trees, irrespective of species, bored in each prism sweep. Mean tree height was calculated by averaging all trees measured in a prism sweep. Basal area factor plus diameter was used to calculate tree density (stems/ha) and basal area (m^2/ha) for each prism sweep (Avery 1975, Husch et al. 1972). Density of trees >30 cm dbh, >40 cm dbh, and >50 cm dbh for each prism sweep were also calculated using the same methods. The density values refer to all trees greater than the specified diameter. Thus, trees >30 cm also include the trees >40 cm and >50 cm. For the above variables, the values were summarized by calculating means and standard errors for each site series within variants. The calculations followed the methods for two-stage sampling described in Husch et al. (1972) and Freese (1962). Means and standard errors were then graphed, by site series within variants, for the following variables: stand age, density of trees >30 cm dbh, >40 cm dbh, and >50 cm dbh. Frequency for each tree class and each tree species was also calculated for each site series within variants. Data analysis was performed using Proc Means and Tabulate of SAS®[3] (SAS Institute Inc. 1988a, 1988b). Graphs were generated using SAS/GRAPH® (SAS Institute Inc. 1988c).

4.2 Variants With Potentially Rare Old Growth

Stand age was calculated by averaging the age for all dominant and codominant trees, irrespective of species, bored in each fixed area plot. Mean tree height was calculated by averaging height for trees assessed for age. Trees per plot, plot size, and diameters were used to calculate tree density (stems/ha) and basal area (m^2/ha) for each sample point (Avery 1975, Husch et al. 1972). Density of trees >30 cm dbh, >40 cm dbh, and >50 cm dbh for each sample point were also calculated using the same methods. As noted above for the BEC data analysis, the densities refer to all trees greater than the specified

[3] SAS is a registered trademark of the SAS Institute Inc., Cary, N.C., USA.

diameters. Thus, trees for the larger diameter classes will be included as part of the density for the smaller-diameter classes. For the above variables, the values were summarized by calculating means and standard errors for each stand sampled. The calculations followed the methods for cluster sampling described in Freese (1962). Frequency for snag class (Backhouse 1993) and tree species was also calculated for each stand. Tree class (B.C. Min. For. 1992d) was approximated by assigning the following values: wildlife tree class 1 = tree class 1, wildlife tree class 2 = tree class 2, wildlife tree classes 3 or 4 = tree class 3, wildlife tree classes 5 or greater = tree class 4. Tree class was calculated because the BEC data had this variable but not snag class; tree class can be approximated from snag class but not vice versa, and some common measure of mortality is desirable for comparing the rare stands to the BEC summary data. Frequency for tree class was calculated for each stand sampled. Density of germinants was calculated by species. Data analysis for the potentially rare old-growth stands was performed using Proc Means and Tabulate of SAS® (SAS Institute Inc. 1988a, 1988b).

4.3 Comparing Potentially Rare Old-Growth Stands To BEC Standards

The BEC summary data was used to define old growth. The mean stand value for the potentially rare old-growth stands were compared to the BEC summary data to determine if the rare stands were old growth. The variables compared included stand age, total tree density, density of trees >30 cm dbh, density of trees >40 cm dbh, density of trees >50 cm dbh, basal area, and tree height. For a particular variable, if the stand mean was equal to or greater than the mean minus one standard error for the same site series and variant in the BEC summary table, the stand was considered to meet the old-growth standard for that variable. For a few potential old-growth stands sampled, mensuration data was not collected for that site series in the BEC sampling program in the NFR. For these stands, the closest site series, in terms of moisture status, was used for comparison. The mean less one standard error was used as the lower confidence limit for the following reason. Two standard errors below the mean would occasionally yield a value of zero or less, which is meaningless for forest management. This occurs in a few cases because the sample size is small or the stands sampled in a site series were inherently variable. A narrower confidence limit should increase the probability that stands sampled and compared to these values are old-growth.

5 RESULTS AND DISCUSSION

5.1 Ecological Classification Sampling And Data Summary

Locations for ecological classification plots with stand age of 140 years or older[4] are indicated in Figure 4. The following discussion notes stand ages and focuses on density of trees >30 cm dbh, >40 cm dbh, and >50 cm dbh. These large-tree attributes are the limiting habitat elements for many wildlife species including cavity nesters (Mannan and Meslow 1984; Thomas et al. 1979). Total tree density, basal area, and average tree height are of interest, but younger stands not meeting old-growth value for wildlife could also meet these criteria. Frequency by tree class and tree species are summarized (Appendices 2 and 3). Brief comments are made on these classes in the discussion. Analysis of all possible combinations of tree species and tree classes within each site series was not undertaken. This type of analysis would have been unnecessarily complex. The number of categories created for each site series from all possible combinations of tree species and tree class would be two orders of magnitude greater than the simple analysis for dimension variables within a site series. As indicated in the methods, the stand age used here is more correctly considered the age of the dominant/codominat strata and may not represent true stand age determined from more complete aging of trees in a stand.

[4] The reader is cautioned that the age criteria for the Old-Growth Strategy and the minimal age defined for old growth (140 years) in this study are less than the definition for old seral stages for many variants in the biodiversity guidebook of the Forest Practices Code (B.C. Min. For. and BC Environ. 1995). For example, old seral stages for ESSFwc1 and ICHmw1 are defined as stands >250 years old. However, old growth was defined for PAS as stands >140 years old. Thus, this age criteria was used as the definition of old growth for all aspects of the present study, including the data analysis and following discussion.

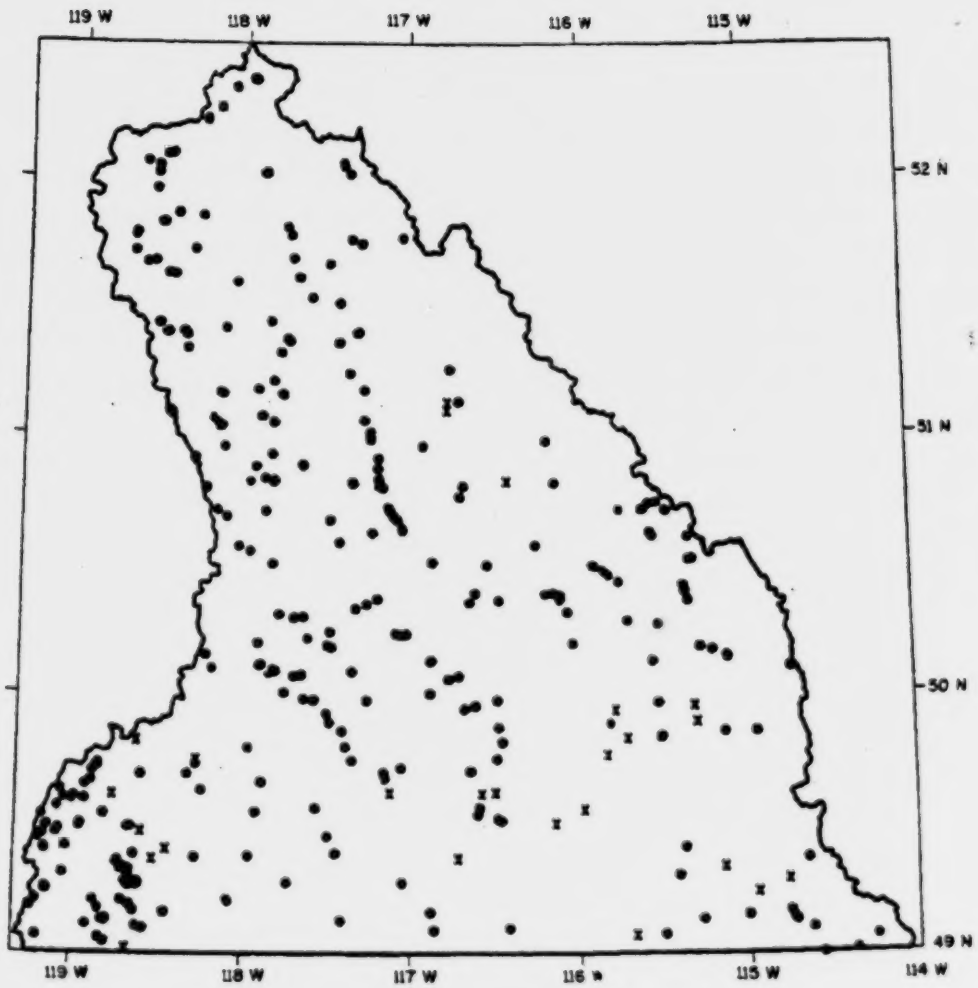

FIGURE 4. Plot locations. BEC plots greater than 140 years old indicated by "•". Rare old-growth stands sampled are indicated by "x".

5.1.1 ESSF Zone

Mean stand age in the ESSF zone is generally between 170 and 230 years (Table 1, Figures 5–7). These values are consistent with age criteria of 150 to 200 years proposed for this zone in British Columbia by the Old-Growth Strategy (B.C. Min. For. 1992a). The values for the BEC old-growth plots also overlap the ages for Engelmann spruce, subalpine fir, and lodgepole pine stands found in intensive sampling studies in the Rocky Mountains (Day 1972; Johnson and Fryer 1989). These values would also meet the minimal age criteria for old growth in high-elevation, Engelmann spruce–subalpine fir forests of northern Idaho, western Montana, and eastern Washington (Green et al. 1992; Williams et al. 1992a). These latter studies were based on large mensuration data sets collected for the ecological classification program in Regions 1 and 6 of the U.S. Forest Service. The species composition for the northern states included subalpine fir, Engelmann spruce, mountain hemlock (*Tsuga mertensiana*), lodgepole pine, and lesser whitebark pine (*Pinus albicaulis*). Western white pine, western larch, Douglas-fir, and grand fir (*Abies grandis*) also occurred, but were generally minor cover types except for favourable microenvironments or lower elevations within these habitat types. By comparison, the species composition for the BEC plots in the ESSF zone was primarily subalpine fir and Engelmann spruce with lesser mountain hemlock and whitebark pine (Appendix 2). Lodgepole pine was an important component in the drier variants.

Mean tree density for trees >30 cm dbh in the BEC plots of the ESSF zone had values ranging between 41 and 337 stems/ha (Table 1; Figures 8-10). One exception was a value of 8 for site series 06 in the ESSFvc. This site series consists of forests with low-density trees to non-forested sites (Braumandl and Curran 1992). For trees >40 cm dbh and trees >50 cm dbh, mean values were as high as 187 stems/ha and 94 stems/ha, respectively. However, for some site series no trees >40 cm dbh were found on any plots. A mean of zero occurred more frequently for site series when the density for >50 cm dbh trees was calculated. This indicates that the density for the >30 cm dbh trees is more consistent and reliable for the ESSF zone. This suggests a general rule of thumb for stands capable of producing old growth in the ESSF zone. A zonal criterion for old growth in the ESSF zone could be 41 stems/ha >30 cm dbh. This zonal criterion is the smallest mean value for site series that produce forests in the ESSF zone. Although stands with values below 41 stems/ha >30 cm could still be old growth, this criterion would be a quick and conservative way of assessing stands, particularly where site series data in the BEC sampling program are missing or only a few stands were sampled. Minimal screening

criterion for comparable old-growth stands in dry or low-productivity areas of northern Idaho and western Montana is 25 stems/ha for all trees >33 cm dbh (Green et al. 1992). In these areas, the same density for trees >43 cm dbh is used in habitat-type groups with greater tree productivity. The density criterion for stands comparable to the ESSF zone in eastern Washington and Oregon is also 25 stems/ha but for larger trees with >53 cm dbh (Williams et al. 1992a). Detailed stand sampling for other studies in the Rocky Mountains found values of 122 to 125 stems/ha for trees >30 cm dbh (Day 1972; Johnson and Fryer 1989). In these two studies, values for densities of trees >40 cm dbh and >50 cm dbh were lower than the values for the BEC plots. In BEC plots of the ESSF zone, frequencies for snags were usually <20% of the total stems with a few stands lacking snags (Appendix 3). Stands without snags may simply represent a relatively young patch in an older stand. Variability of age within a stand often results because fire, insect, and disease activity is patchy in distribution and rarely affects a stand uniformly. The snag data suggest that old-growth stands in the ESSF zone usually have snags but mortality is commonly <20% of the stand.

TABLE 1. BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the ESSF zone

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
ESSFdc1	01	9	191.9(25.06)[a]	150.4(20.88)	18.6(12.11)	6.8(5.51)	1 179.7(160.16)	47.0(4.21)	18.3(1.07)
	03	7	178.6(9.35)	62.9(22.65)	2.1(2.12)	0.0(0.00)	1 522.5(346.19)	40.4(4.79)	17.6(1.50)
	04	10	176.9(5.29)	310.0(46.55)	96.3(33.12)	22.5(13.76)	1 103.0(314.25)	59.5(4.22)	25.2(2.10)
	05	10	194.6(7.63)	214.5(35594)	47.3(14.95)	15.9(8.32)	1 136.7(202.66)	50.5(7.13)	20.6(2.29)
	06	4	167.2(13.53)	192.9(90.56)	63.2(36.67)	23.7(17.15)	966.8(60.37)	47.7(7.36)	19.2(0.52)
ESSFdk	01	2	181.2(16.46)	263.1(20.22)	119.7(45.44)	63.3(17.84)	794.6(296.67)	52.5(3.50)	17.4(2.30)
	02	1	179.3(-[b])	264.2(-)	60.4(-)	37.5(-)	857.7(-)	52.0(-)	17.6(-)
	03	10	187.4(15.23)	188.9(40.62)	54.0(25.85)	17.3(9.38)	1 369.0(195.10)	54.0(4.32)	18.5(1.04)
	04	11	217.7(11.56)	169.1(29.07)	57.5(14.13)	29.0(13.37)	1 440.8(257.75)	55.5(5.08)	18.6(1.32)
	05	3	169.9(12.54)	237.5(46.16)	67.7(34.19)	18.0(11.48)	2 353.8(983.51)	61.3(3.71)	15.9(5.18)
	06	2	175.6(3.62)	250.1(33.78)	83.9(7.26)	29.0(28.98)	788.4(66.76)	46.5(1.50)	17.1(0.88)
ESSFdkp	-[c]	1	261.7(-)	320.5(-)	0.0(-)	0.0(-)	486.5(-)	36.0(-)	17.0(-)
ESSFvc	01	9	172.5(7.66)	216.9(31.99)	139.7(29.65)	64.6(16.19)	531.4(171.12)	47.8(5.74)	23.8(1.62)[d]
	02	4	190.8(22.14)	249.9(49.37)	129.7(57.09)	84.0(59.91)	1 358.9(609.32)	58.9(9.12)	17.4(5.35)
	03	3	203.0(6.05	317.2(47.66)	119.1(47.68)	76.8(49.70)	814.6(213.19)	68.6(2.33)	23.0(3.36)
	04	2	164.7(2.67)	243.4(30.45)	119.3(16.44)	59.6(5.47)	415.8(19.83)	49.2(0.85)	29.0(0.25)
	05	4	208.1(14.41)	280.4(65.59)	141.1(30.13)	80.4(28.64)	424.0(132.72)	58.1(13.99)	27.4(2.49)

TABLE 1. (continued)

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
ESSFvc	06	1	151.0(-)	8.1(-)	8.1(-)	8.1(-)	852.0(-)	13.8(-)	8.2(-)
ESSFvcp	-	2	157.5(2.00)	190.8(49.85)	7.0(6.98)	0.0(0.00)	1185.7(386.35)	45.4(13.22)	15.0(0.57)
ESSFwc1	01	4	167.0(6.95)	336.8(19.67)	144.3(14.21)	64.0(20.69)	572.6(103.21)	57.1(2.58)	24.6(2.11)[c]
	02	2	174.5(11.50)	287.7(43.36)	126.0(41.11)	55.3(42.32)	1016.8(256.78)	61.9(10.13)	21.5(4.28)
	03	4	164.1(12.05)	270.5(64.75)	162.2(23.49)	89.8(14.61)	443.5(113.78)	57.4(6.90)	26.7(3.01)
	04	1	170.0(-)	278.7(-)	187.8(-)	62.8(-)	278.7(-)	52.0(-)	36.6(-)
	05	1	219.5(-)	98.4(-)	15.9(-)	0.0(-)	960.9(-)	40.0(-)	17.4(-)
ESSFwc2	01	2	205.5(3.50)	269.7(0.94)	155.4(32.58)	28.5(0.95)	538.2(19.33)	52.9(1.12)	24.0(1.15)
	04	3	179.1(18.94)	301.1(89.13)	135.8(63.16)	23.4(21.42)	758.8(254.06)	55.2(18.26)	22.4(1.05)
	05	3	209.2(8.24)	264.4(20.52)	124.3(38.57)	40.8(40.81)	585.1(185.23)	45.4(4.35)	20.1(1.53)
ESSFwc4	01	12	170.3(6.36)	283.1(34.54)	149.6(17.81)	60.0(9.21)	567.0(63.58)	54.1(5.29)	24.5(1.21)
	02	6	189.5(11.49)	159.8(26.53)	56.1(22.02)	16.8(11.07)	1315.5(177.86)	47.8(6.04)	13.5(1.65)
	03	4	163.7(11.52)	213.8(67.48)	72.7(35.17)	24.5(13.73)	1156.7(346.83)	52.1(17.34)	14.4(1.71)
	04	7	211.6(19.26)	253.3(36.46)	128.1(29.28)	52.7(17.62)	949.6(195.88)	56.2(5.06)	20.8(0.75)
	05	3	188.2(30.43)	195.3(72.89)	118.6(39.91)	88.4(34.73)	327.9(199.62)	48.3(14.96)	27.9(3.36)
	07	3	168.7(1.88)	74.7(42.89)	30.3(26.03)	8.7(5.01)	563.8(148.02)	21.7(4.10)	15.7(2.70)
	08	2	195.3(28.75)	57.4(8.30)	11.9(3.92)	0.0(0.00)	615.0(14.23)	15.5(0.57)	13.4(3.24)

TABLE 1. (continued)

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
ESSFwcp	-	3	166.9(18.75)	106.6(46.04)	51.3(17.06)	17.5(9.26)	216.6(54.59)	21.1(5.57)	19.2(2.00)
ESSFwm	01	7	190.2(10.55)	286.3(37.10)	135.9(33.32)	65.2(26.21)	959.4(276.61)	60.1(5.42)	24.5(2.77)
	02	1	344.5(-)	41.3(-)	0.0(-)	0.0(-)	906.5(-)	38.0(-)	10.8(-)
	03	1	160.4(-)	224.6(-)	187.3(-)	94.3(-)	301.1(-)	52.0(-)	26.5(-)
	04	2	180.6(25.62)	290.0(79.56)	71.0(45.00)	20.9(20.86)	1071.0(393.71)	54.1(8.05)	18.1(5.28)

[a] Mean with standard error in brackets.
[b] "-" indicates missing data or value could not be calculated.
[c] Site series have not been established for this variant.
[d] n = 8 for this variable.
[e] n = 3 for this variable.

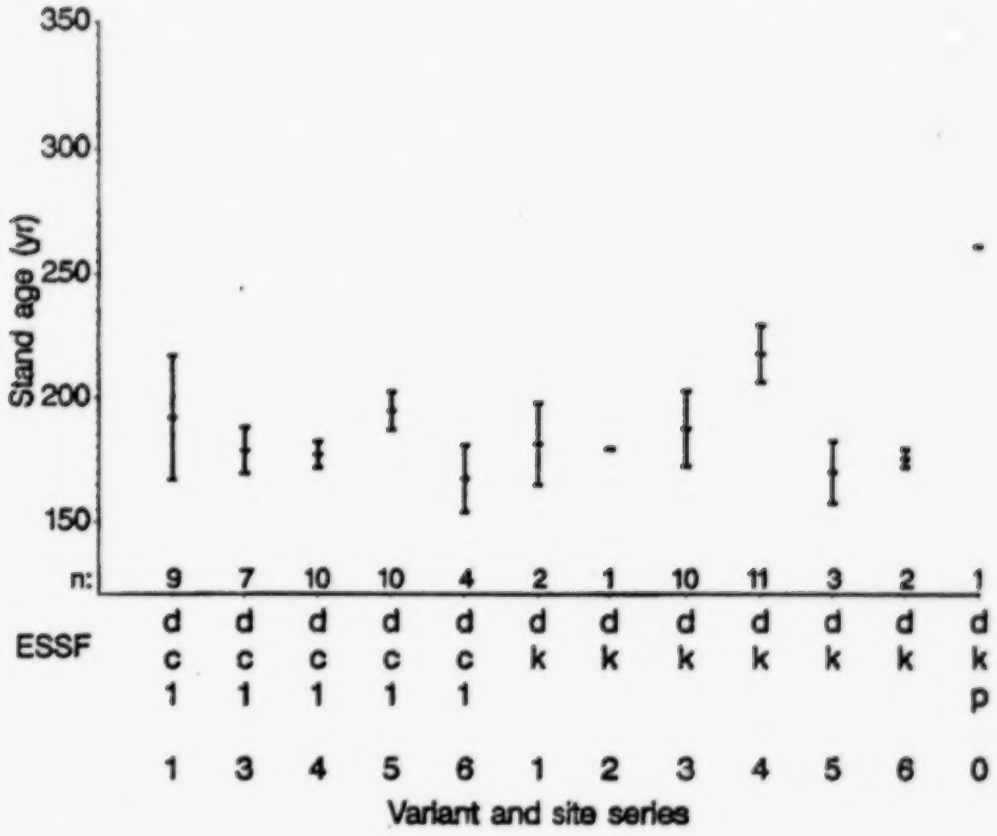

FIGURE 5. Stand ages by site series for the ESSFdc1, ESSFdk, and ESSFdkp variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

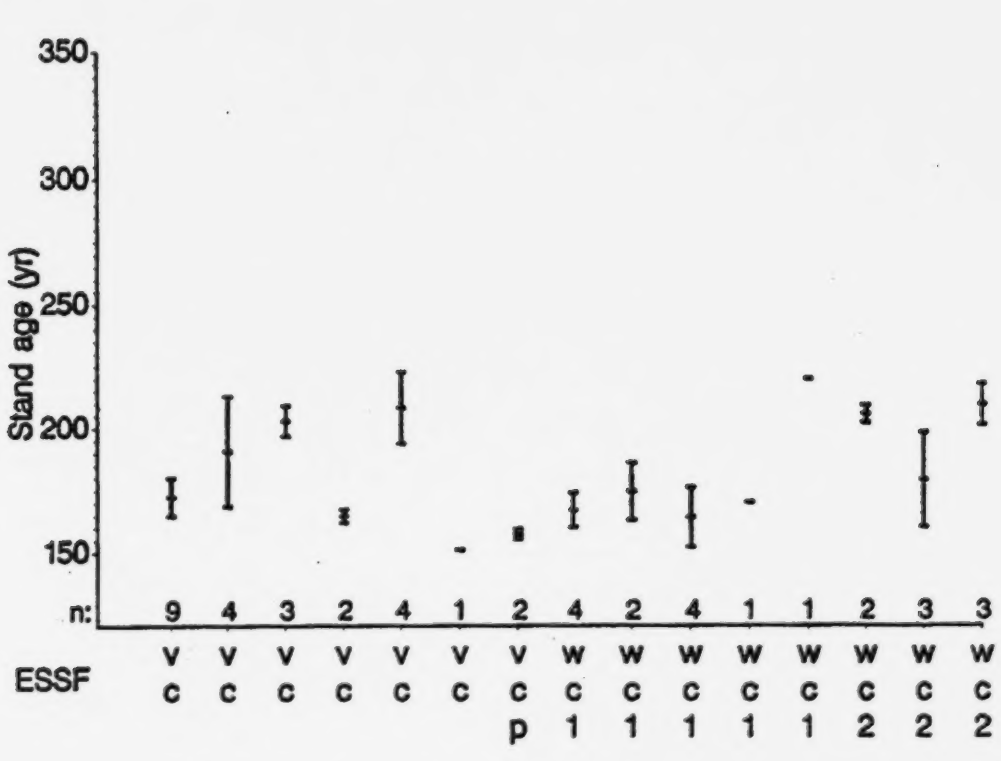
350
300
250
200
150
Stand age (yr)
n:
9 4 3 2 4 1 2 4 2 4 1 1 2 3 3
ESSF
v v v v v v v w w w w w w w w
c c c c c c c c c c c c c c c
p 1 1 1 1 1 2 2 2
1 2 3 4 5 6 0 1 2 3 4 5 1 4 5
Variant and site series

FIGURE 6. Stand ages by site series for the ESSFvc, ESSFvcp, ESSFwc1, and ESSFwc2 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

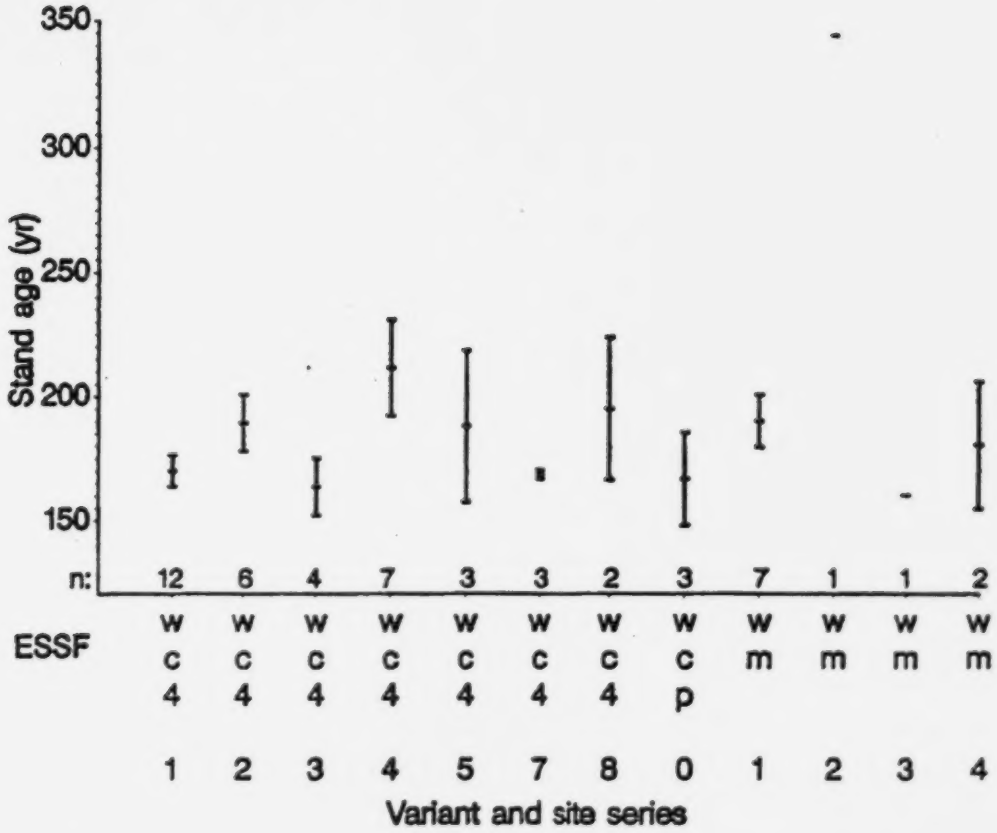
350
300
250
200
150
Stand age (yr)
n:
12 6 4 7 3 3 2 3 7 1 1 2
ESSF
w w w w w w w w w w w w
c c c c c c c c m m m m
4 4 4 4 4 4 4 p
1 2 3 4 5 7 8 0 1 2 3 4
Variant and site series

FIGURE 7. Stand ages by site series for the ESSFwc4, ESSFwcp, and ESSFwm variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

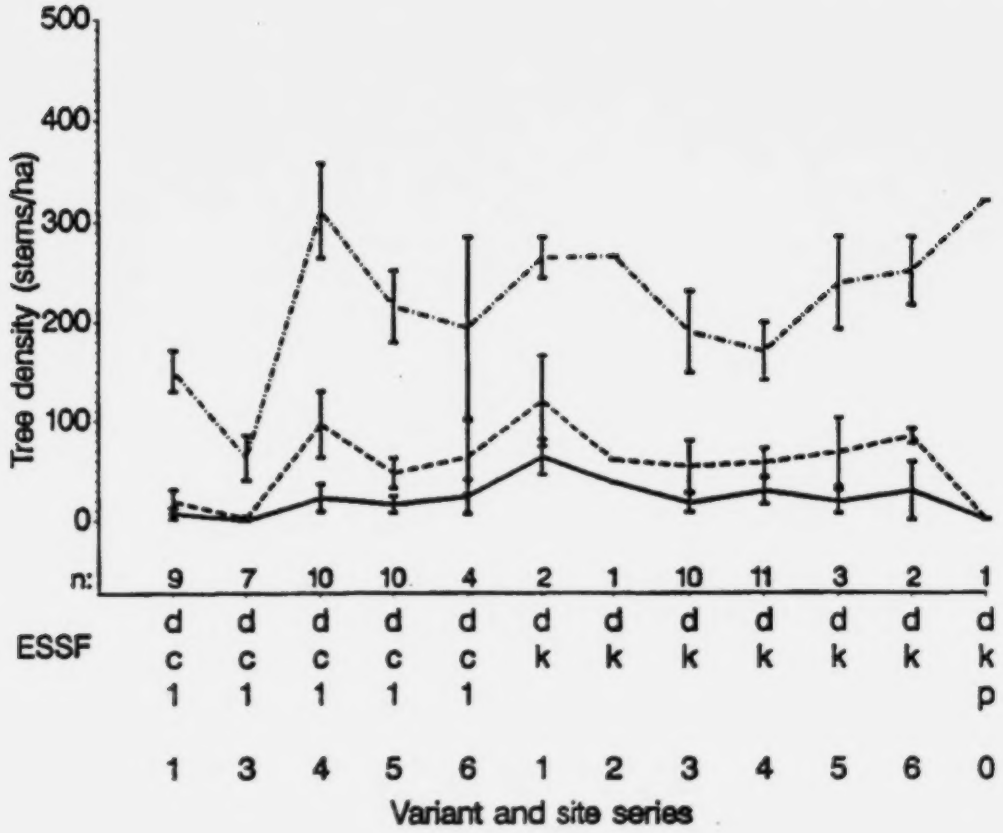
500
400
300
200
100
0
Tree density (stems/ha)
n:
9 7 10 10 4 2 1 10 11 3 2 1
ESSF
d d d d d d d d d d d d
c c c c c k k k k k k k
1 1 1 1 1 p
1 3 4 5 6 1 2 3 4 5 6 0
Variant and site series

FIGURE 8. Densities of large-dimension trees by site series in the ESSFdc1, ESSFdk, and ESSFdkp variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

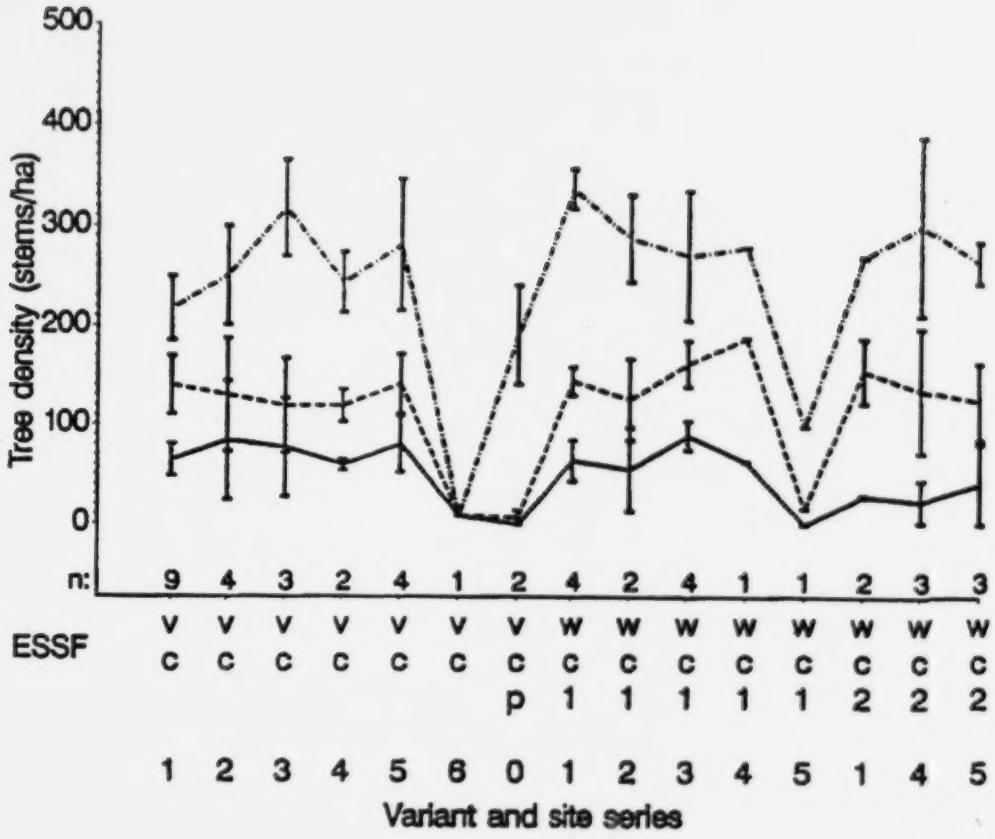
500
400
300
200
100
0
Tree density (stems/ha)
n:
9 4 3 2 4 1 2 4 2 4 1 1 2 3 3
ESSF
v v v v v v v w w w w w w w w
c c c c c c c c c c c c c c c
p 1 1 1 1 1 2 2 2
1 2 3 4 5 6 0 1 2 3 4 5 1 4 5
Variant and site series

FIGURE 9. Densities of large-dimension trees by site series in the ESSFvc, ESSFvcp, ESSFwc1, and ESSFwc2 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

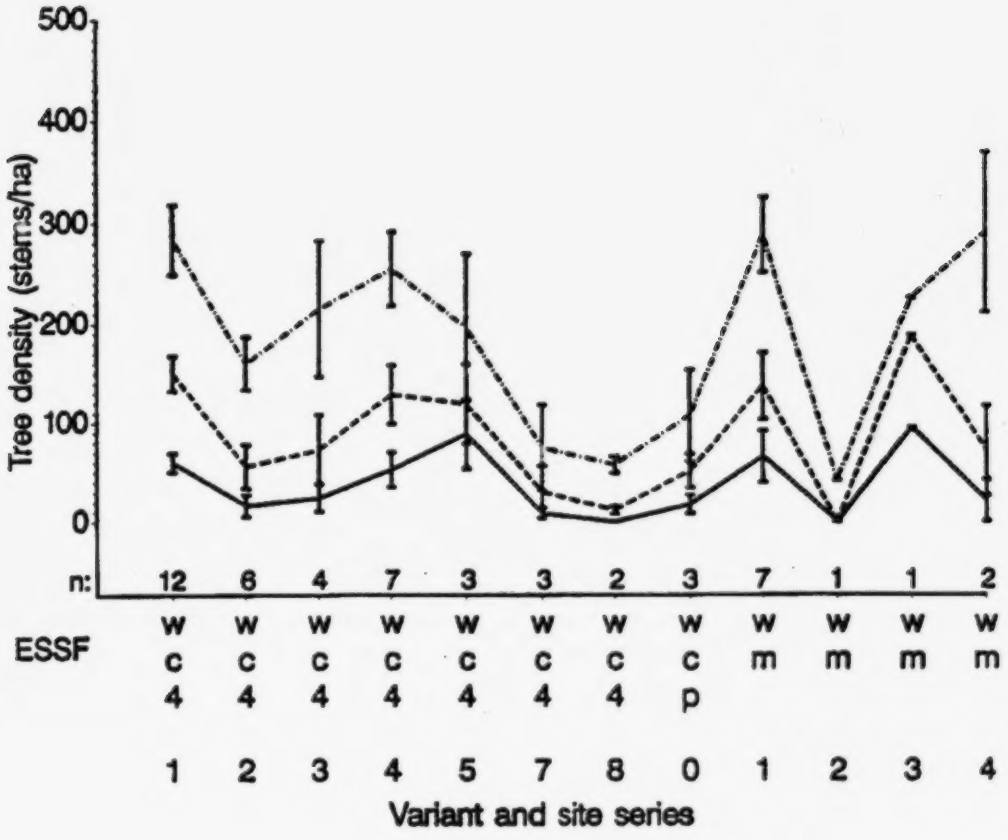
500
400
300
200
100
0
Tree density (stems/ha)
n:
12 6 4 7 3 3 2 3 7 1 1 2
ESSF
w w w w w w w w w w w w
c c c c c c c c m m m m
4 4 4 4 4 4 4 p
1 2 3 4 5 7 8 0 1 2 3 4
Variant and site series

FIGURE 10. Densities of large-dimension trees by site series in the ESSFwc4, ESSFwcp, and ESSFwm variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

5.1.2 ICH Zone

Mean stand age in the ICH zone is between 141 and 229 years (Table 2; Figures 11 and 12). This is the greatest range in means for site series amongst all the zones sampled for this study (Tables 1–4; Figures 5–7, 11 and 12, 15, 17). This probably reflects a greater range in precipitation in this zone and hence a greater range in disturbance frequency for this zone compared to other zones in the NFR. The recommended minimal age for old-growth stands in the ICH zone is 150 years (B.C. Min. For. 1992a). Minimal age criteria is 150 to 180 years for stands with comparable forest cover in northern Idaho and western Montana (Green et al. 1992). Values for these criteria in Idaho and Montana are below or cover the lower part of the range found for stand ages in detailed studies from eastern Oregon, northern Idaho, and northern Montana (Habeck 1978; Mannan and Meslow 1984; Moeur 1992). For example, Habeck (1978) sampled stands of western redcedar and grand fir with ages from 315 to 600 years. Habeck had limited his analysis to stands >300 years as few, if any, seral species still remained in the stand. Eighteen stands from the BEC plots in the ICH zone had ages between 230 and 300 years old. One stand was aged at 314 years. With the exception of the ICHdw and ICHxw variants, grand fir is not found in the NFR (Appendix 2). Western hemlock is common in old-growth stands in the ICH zone, hybrid white spruce (*Picea glauca* x *engelmannii*) and subalpine fir often occur as minor components indicating transition to higher-elevation or more northerly ecosystems, and seral species such as Douglas-fir, western larch, and western white pine occur in low frequency. These tree species, differences indicate that the BEC plots were at a slightly earlier seral stage compared to the stands sampled by Habeck (1978). This result merely confirms the expected results when two studies have significantly different target populations in terms of stand age. In contrast, species composition in the ICH zone is similar to stands sampled in northern Idaho by Moeur (1992). Four of her stands had ages in the 200-to-300 year range. Thus, ages for old-growth stands in the ICH zone appear comparable to those of northern Idaho. The studies cited above were intensive and not extensive. The ages may represent exceptionally old stands rather than the norm for old growth in these areas. This may explain the younger average stand age found with the BEC sampling program. The effect on average stand age of extensive sampling is in addition to the use of a minimal age of 140 years for plot selection.

Mean density for trees >30 cm dbh in the BEC plots of the ICH zone ranged from 174 to 409 stems/ha (Table 2; Figures 13 and 14). The ranges for densities of trees >40 cm dbh and >50 cm dbh was 14 to 262 stems/ha and 10 to 207 stems/ha, respectively. For the

density of trees >50 cm dbh, most site series had mean values greater than 36 stems/ha. Wetter variants (ICHwk1 and ICHvk1) had mean values above 60 stems/ha for trees >50 cm dbh. This suggests a general rule of thumb for old growth in the ICH zone in the NFR. The zonal criteria would be densities for trees >50 cm dbh of 36 stems/ha for the drier variants and 60 stems/ha for the wetter variants. As indicated earlier for the ESSF zone, these zonal criteria would be ecologically conservative values based on the lowest mean for site series capable of growing forests. A study on cavity-nesting birds and associated tree species in an old-growth stand in northeastern Oregon found a mean density for trees >50 cm dbh of 48 stems/ha (Mannan and Meslow 1984). This stand is similar to stands found in the ICHdw in the NFR, and supports the suggestion that 36 stems/ha >50 cm dbh is a reasonable criteria for drier variants in the ICH zone. For stands similar to the ICH zone in northern Idaho and western Montana, minimal screening criteria for old-growth varies from 25 stems/ha for trees >43 cm dbh to the same density for trees >63 cm dbh (Green et al. 1992). The variation reflects differences in site productivity and regional climate. A detailed stand sampling study in northern Idaho and Montana by Habeck (1978) found densities for trees >30 cm dbh to range from 107 to 453 stems/ha, while densities for trees >50 cm dbh ranged from 27 to 293 stems/ha. Stand ages in Habeck's study ranged from >300 to 600 years old. These density values are comparable to the BEC plots from the ICH zone (Table 2). A second detailed stand sampling study from northern Idaho found greater densities for larger trees than those obtained in plots from the ICH zone. For example, the stands from northern Idaho had densities of 356 to 555 stems/ha for trees >38 cm dbh (Moeur 1992). These values are greater than densities for trees >40 cm dbh on comparable stands in the ICH zone (Table 2). The stands from the northern Idaho study were estimated to have snag frequencies of 38 to 74% in the >38 cm dbh class and 32 to 81% in the >53 cm dbh class. By comparison, most site series in the ICH zone had snag frequencies of <20% (Appendix 3). Part of the difference may simply be that the detailed sampling study of Moeur (1992) focused on exceptionally old stands with high mortality rates compared to the more extensive sampling of the BEC program. The BEC program included younger stands that probably had lower mortality. Also, high stand mortality in Idaho, eastern Oregon, and Washington is a concern and has been the subject of recent studies (Lehmkuhl et al. 1994; O'Laughlin et al 1993).

TABLE 2. BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the ICH zone

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
ICHdw	01a	3	189.1(29.47)[a]	348.4(59.33)	144.3(11.57)	39.0(25.71)	864.1(169.11)	64.0(4.62)	17.7(2.05)
	01b	3	152.3(6.10)	408.6(72.12)	225.5(102.37)	103.9(45.74)	1200.0(443.53)	84.0(6.93)	20.0(2.63)
	03	2	157.2(5.32)	258.7(62.36)	130.8(75.47)	70.3(62.92)	893.3(420.19)	64.0(8.00)	22.6(4.41)
ICHmk1	01	7	163.2(5.92)	245.9(57.46)	82.3(26.61)	38.9(14.27)	908.8(99.33)	51.3(3.56)	23.8(1.83)
	03	2	180.2(2.83)	224.3(193.86)	121.8(121.78)	20.3(20.32)	753.4(257.35)	44.9(14.95)	20.8(2.73)
	04	3	170.0(12.94)	180.5(40.23)	13.9(6.93)	9.7(6.16)	1175.8(406.60)	48.7(15.35)	20.2(1.74)
	05	3	183.1(26.02)	311.4(30.54)	169.9(46.23)	36.4(18.45)	571.0(62.57)	51.4(8.84)	27.7(1.14)
	06	3	160.5(11.76)	363.6(108.99)	227.9(95.40)	104.8(39.58)	793.7(207.83)	79.6(11.74)	22.7(0.55)
ICHmw1	01	2	180.6(27.58)	399.3(34.40)	262.7(3.64)	126.4(16.88)	543.6(35.24)	75.8(2.20)	28.3(0.10)
	05	1	229.0(-[b])	207.0(-)	207.0(-)	207.0(-)	743.5(-)	101.2(-)	29.3(-)
	06	3	211.2(38.66)	264.4(13.16)	208.8(15.11)	138.7(27.52)	661.1(176.34)	80.9(5.65)	24.5(3.88)
ICHmw2	01	14	197.8(14.90)	280.6(32.02)	166.3(14.88)	77.0(11.92)	529.7(97.51)	56.4(4.43)	23.4(1.67)
	03	1	220.7(-)	174.4(-)	116.1(-)	104.8(-)	430.4(-)	56.0(-)	19.8(-)
	04	6	184.0(11.73)	257.0(17.38)	170.6(30.75)	100.3(22.21)	748.9(211.28)	62.7(2.86)	22.5(2.43)
	05	12	184.6(8.72)	239.2(28.45)	174.0(14.14)	121.4(11.55)	395.2(58.44)	77.0(8.50)	25.7(1.07)
	06	9	181.8(11.97)	248.4(56.93)	176.6(29.54)	123.4(18.01)	696.7(181.65)	86.3(12.52)	21.4(2.53)

TABLE 2. (continued)

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 m dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
ICHvk1	01	8	192.9(14.06)	230.6(36.44)	167.5(24.54)	123.3(14.73)	408.6(99.46)	83.2(6.53)	25.5(2.55)
	03	5	202.6(12.11)	281.2(72.28)	194.6(28.18)	115.0(36.51)	773.9(109.78)	76.0(12.79)	14.1(1.80)[c]
	04	8	200.0(11.72)	213.2(18.85)	191.9(16.99)	145.6(18.01)	631.9(184.01)	91.0(7.38)	26.1(3.56)[d]
	05	1	141.0(-)	216.1(-)	216.1(-)	167.3(-)	216.1(-)	119.6(-)	-(-)
	06	4	202.4(12.03)	236.8(46.01)	135.6(28.81)	78.9(32.76)	512.8(142.02)	56.2(1.97)	20.5(2.31)
ICHwk1	01	15	178.4(6.91)	303.1(35.43)	239.7(19.03)	137.7(9.99)	661.2(139.61)	93.3(7.12)	26.4(1.87)
	04	18	180.9(9.70)	316.2(34.46)	205.9(14.32)	111.5(14.33)	735.1(182.54)	72.1(4.75)	23.6(1.47)
	05	12	169.7(6.81)	263.3(26.36)	218.4(23.26)	167.2(21.82)	311.7(35.74)	92.4(7.25)	30.1(1.15)
	06	2	182.3(8.82)	242.3(24.84)	121.6(48.95)	59.9(59.87)	361.2(143.78)	53.0(9.05)	31.7(8.59)
	08	1	148.0(-)	199.1(-)	165.7(-)	93.0(-)	404.2(-)	68.0(-)	24.7(-)

[a] Mean with standard error in brackets.
[b] "-" indicates missing data or value could not be calculated.
[c] n = 4 for this variable.
[d] n = 7 for this variable.

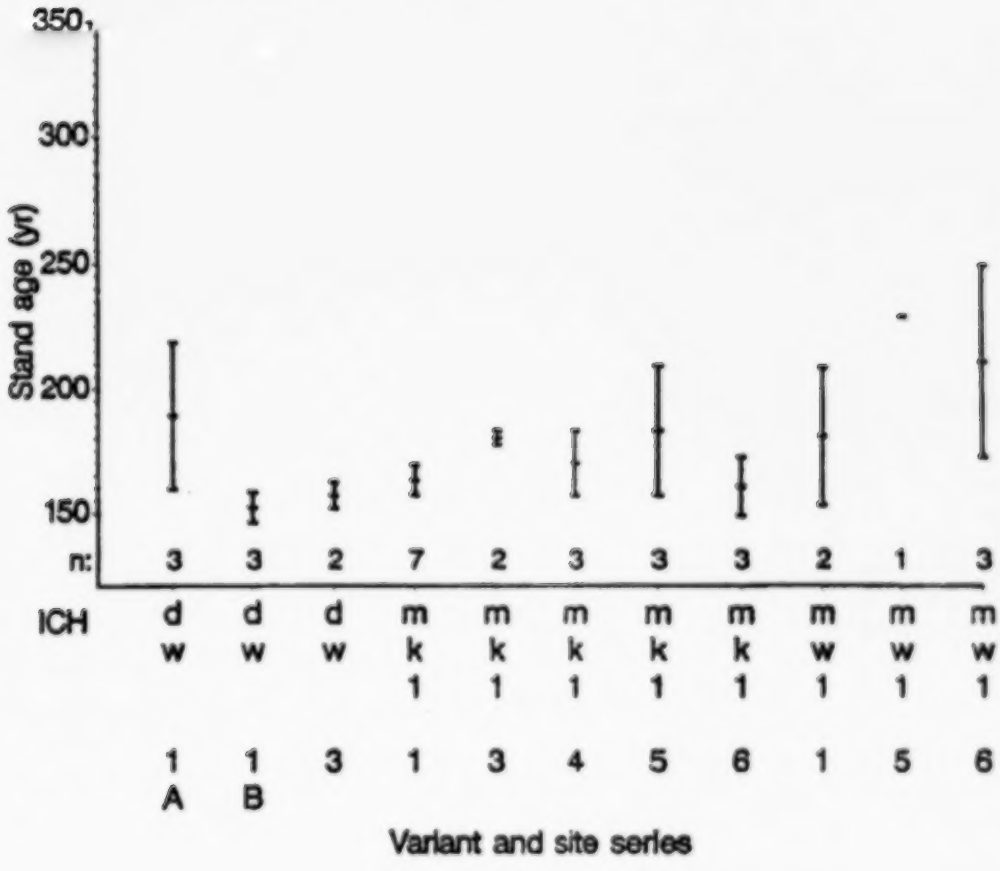

FIGURE 11. Stand ages by site series for the ICHdw, ICHmk1, and ICHmw1 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

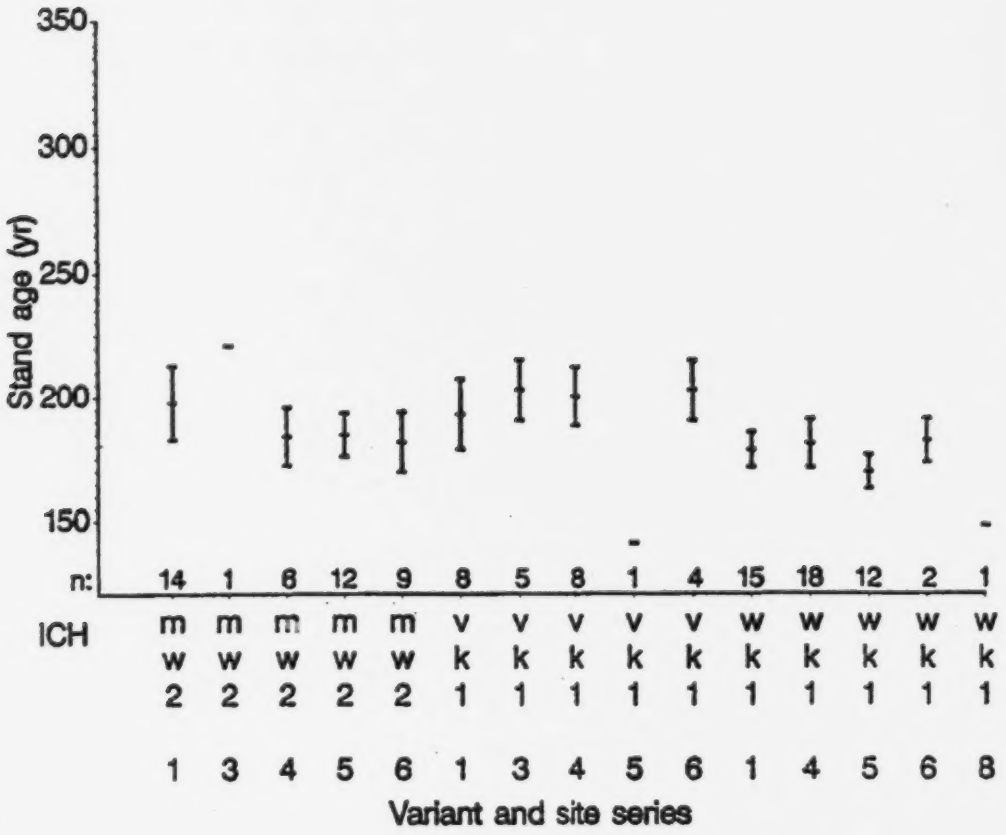
350
300
250
200
150
Stand age (yr)
n:
14 1 6 12 9 8 5 8 1 4 15 18 12 2 1
ICH
mww2 mww2 mww2 mww2 mww2 vk1 vk1 vk1 vk1 vk1 wk1 wk1 wk1 wk1 wk1
1 3 4 5 6 1 3 4 5 6 1 4 5 6 8
Variant and site series

FIGURE 12. Stand ages by site series for the ICHmw2, ICHvk1, and ICHwk1 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

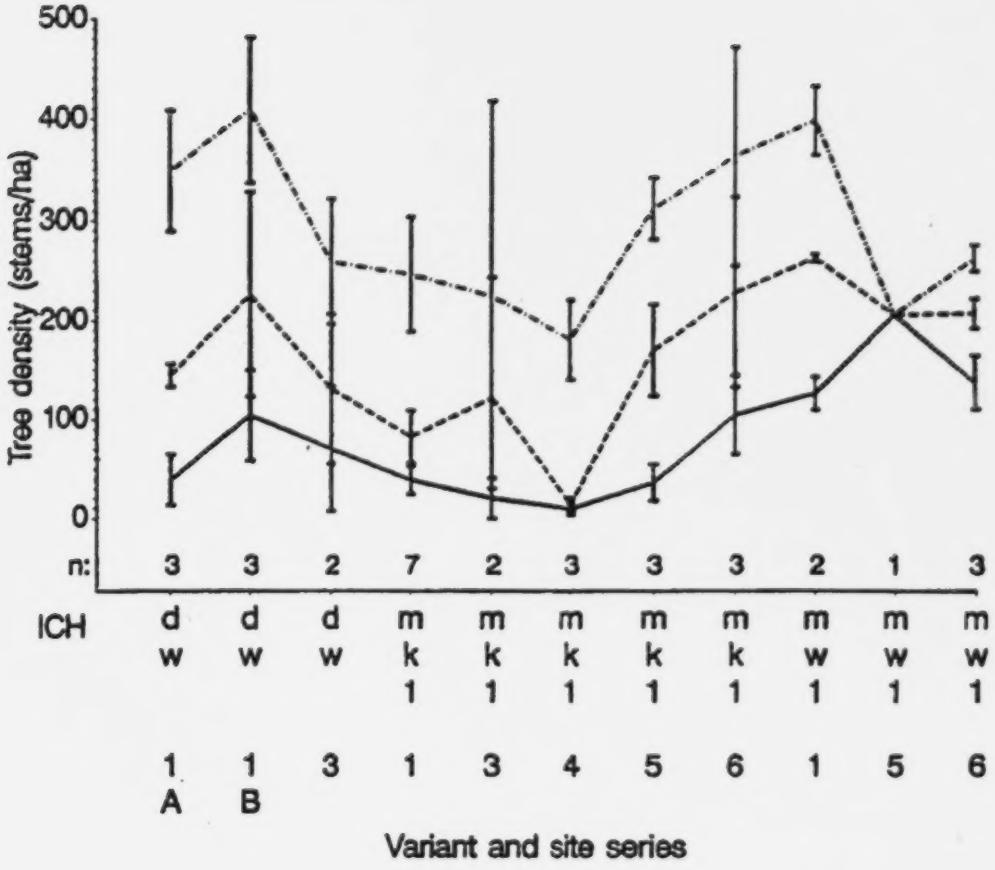

FIGURE 13. Densities of large-dimension trees by site series in the ICHdw, ICHmk1, and ICHmw1 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

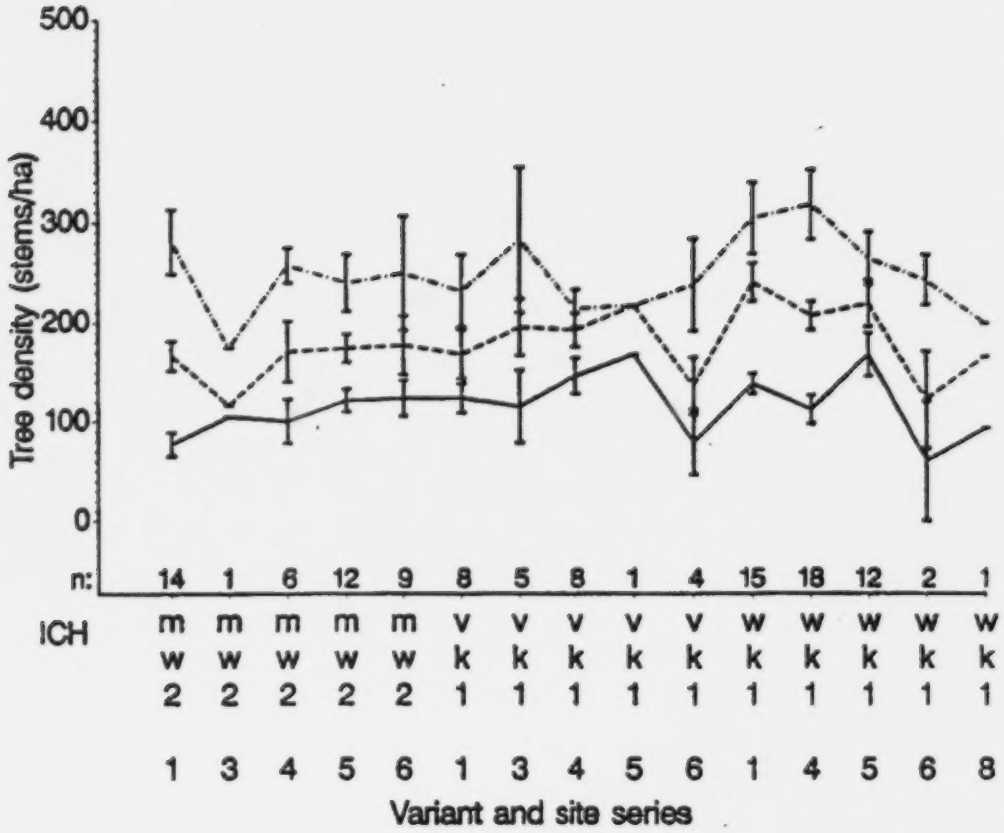

FIGURE 14. Densities of large-dimension trees by site series in the ICHmw2, ICHvk1, and ICHwk1 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

5.1.3 IDF Zone

Mean stand age for site series sampled in the IDF zone ranged from 140 to 184 years (Table 3; Figure 15). Three of the site series had mean stand ages that were less than the 150-year minimum recommended for the IDF zone in British Columbia (B.C. Min. For. 1992a). The same minimal screening age of 150 years is recommended for old-growth stands, similar to the IDF zone, in northern Idaho (Green et al. 1992) and eastern Washington (Williams et al. 1992b). The sample size per site series was minimal for half the site series in the IDF zone (Table 3; Figure 15). Limited sample size for these units suggests caution when extrapolating these results to the rest of the zone. For site series with greater sample sizes, mean stand age is 145 to 184 years, which should better reflect old-growth stands in the IDF zone. Limited sample size for some units is not too surprising as variants in this zone have been identified as units with limited areas of potential old growth (Quesnel and Leahy 1993). In the literature, the closest example to an old-growth stand in the IDF zone is a south-facing slope in the Washoe Creek drainage (Tesch 1981). This detailed stand sampling study was located 66 km northeast of Missoula, Montana, and was similar vegetatively to the 01 site series of the IDFdm1 variant (Braumandl and Curran 1992). Tesch (1981) found that many trees were over 240 years old including two trees almost 400 years old. As noted previously, detailed studies on limited sites may have selected exceptionally old stands. In contrast, the extensive sampling of the BEC program combined with an age criteria of 140 years yielded a data set with younger stands. However, there were individual stands in the IDF zone that were over 200 years old, and a maximum stand age of 230 years was found on one plot. This latter age is only a few decades less than the stand studied by Tesch (1981).

Mean density for trees >30 cm dbh in the IDF zone ranged from 58 to 300 stems/ha (Table 3; Figure 16). The range for mean density of trees >40 cm dbh and >50 cm dbh was 58 to 212 stems/ha and 17 to 114 stems/ha, respectively. This suggests that a useful rule of thumb for old-growth stands in the IDF zone would be zonal criteria of 17 stems/ha >50 cm dbh and 58 stems/ha >40 cm dbh, based on the lowest mean values for site series in the zone. Tesch (1981) found densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh of 117stems/ha, 78 stems/ha, and 41 stems/ha, respectively, for an old-growth stand composed primarily of Douglas-fir and ponderosa pine. Tesch's densities for trees >40 cm dbh and >50 cm dbh are within the range for the mean values in the IDF zone from the BEC data (Table 3). This supports the suggestion that Tesch's stands and the BEC sample plots in the IDF zone are comparable. The minimal screening criterion

recommended for old-growth stands of Douglas-fir, with lesser ponderosa pine, western larch, and lodgepole pine in northern Idaho and eastern Washington is 20 stems/ha for trees >53 cm dbh (Green et al. 1992; Williams et al. 1992b). The recommended number of snags/ha in these areas varies from 0 to 18 stems/ha >22.5 cm dbh (Green et al. 1992) to 2.5 stems/ha >30 cm dbh (Williams et al. 1992b). The snag frequency for minimal screening criteria in eastern Washington is approximately 13% of the total number of stems and snags can have slightly smaller diameters than the live trees (Williams et al. 1992b). Alternatively, snag recommendations are more varied, and smaller-sized snags are considered for different habitat types of northern Idaho (Green et al. 1992). The recommended values include snag densities from 0 to almost half of the total number of stems in a stand. As indicated earlier, areas of northern Idaho and Montana appear to have exceptionally high conifer mortality rates (Lehmkuhl et al. 1994; O'Laughlin et al 1993). Snag frequencies for BEC old-growth plots in the IDF zone were generally 10 to 33% (Appendix 3). This range of values is comparable to the minimum recommended for northern Idaho (Green et al. 1992). This may indicate similar forest health factors in the IDF zone as for northern Idaho (O'Laughlin et al 1993).

TABLE 3. BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the IDF zone

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
IDFdm1	01	6	168.6(8.13)[a]	189.9(42.41)	86.2(29.38)	16.8(8.88)	1 182.1(252.92)	41.2(5.79)	19.7(1.10)
	03	1	172.3(-[b])	300.0(-)	212.5(-)	73.9(-)	358.9(-)	60.0(-)	22.4(-)
	04	7	183.5(12.67)	180.9(46.38)	71.9(18.05)	30.3(12.73)	676.3(142.24)	36.0(5.22)	17.8(1.93)
	05	3	166.3(12.68)	153.8(30.13)	79.8(25.29)	32.5(20.19)	936.1(133.55)	43.5(3.72)	21.9(0.81)
	06	1	140.0(-)	149.5(-)	149.5(-)	113.5(-)	149.5(-)	63.0(-)	38.9(-)
IDdm2	01	2	145.3(0.25)	176.0(71.07)	71.5(36.81)	22.1(22.05)	548.3(112.19)	34.0(7.00)	19.5(1.71)
	03	1	141.0(-)	268.8(-)	133.7(-)	27.2(-)	374.6(-)	38.0(-)	17.0(-)
IDFun	-[c]	1	159.0(-)	58.3(-)	58.3(-)	29.4(-)	58.3(-)	12.0(-)	26.3(-)

[a] Mean with standard error in brackets.
[b] "-" indicates missing data or value could not be calculated.
[c] Site series have not been established for this variant.

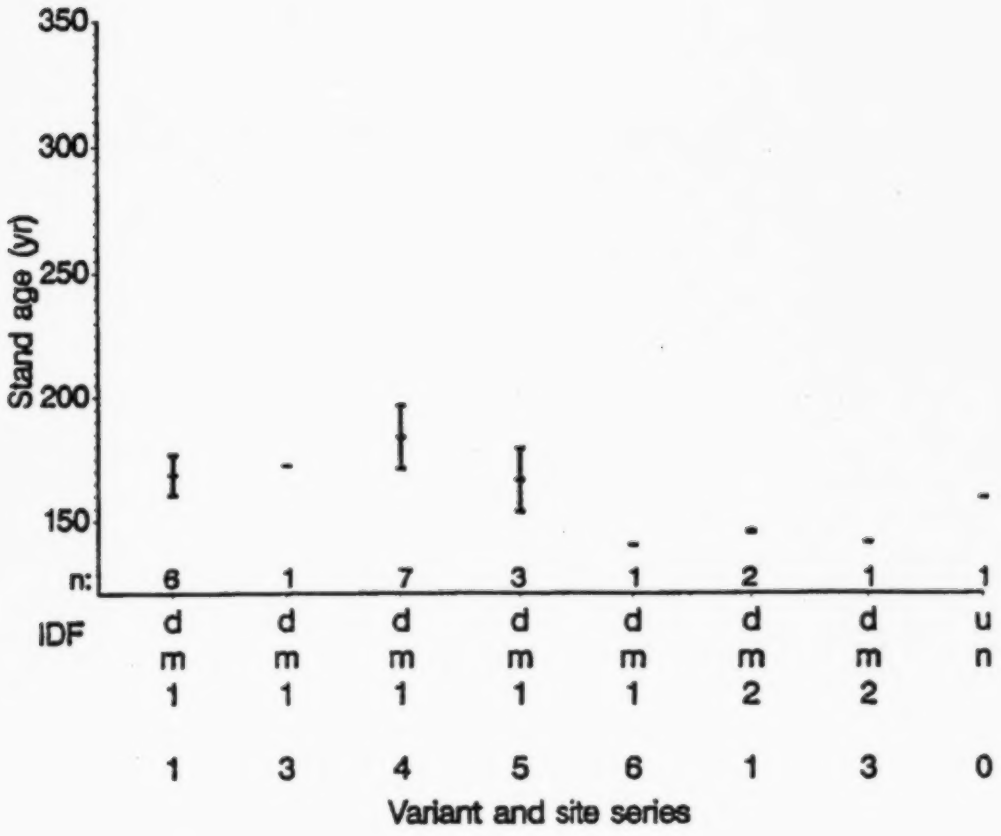

FIGURE 15. Stand ages by site series for the IDFdm1, IDFdm2, and IDFun variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

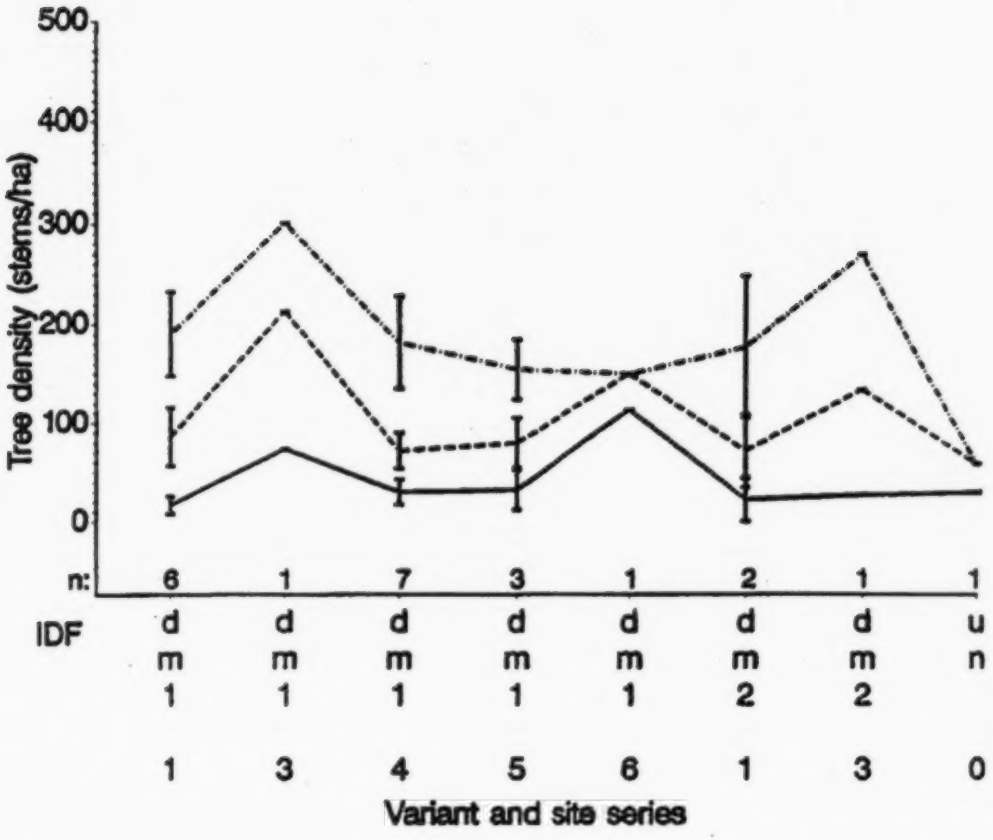

FIGURE 16. Densities of large-dimension trees by site series in the IDFdm1, IDFdm2, and IDFun variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

5.1.4 MS Zone

Mean stand age for site series in the MS zone ranged from 150 to 195 years (Table 4; Figure 17). In general, these values were greater than the 150-year minimum recommended for the MS zone in British Columbia (B.C. Min. For. 1992a). This minimum was for stands dominated by Douglas-fir, western larch, or Engelmann spruce. The recommended minimal age for old-growth stands dominated by lodgepole pine is 120 years. Minimal screening ages for similar stands in western Montana vary from 150 years, where lodgepole pine is the climax species, to 180 years where Douglas-fir, subalpine fir, Engelmann spruce, or western redcedar are the climax species (Green et al. 1992). Tesch (1981) sampled a stand on a north aspect that was established 240 years ago and had tree species composition similar to the MS zone. The stand in Tesch's study was dominated by an overstory of Douglas-fir, lodgepole pine, and western larch. This stand also had large numbers of subdominants and seedlings of Engelmann spruce and subalpine fir. This tree species composition is comparable to mesic site series in the MSdm1 and MSdk variants (Appendix 2).

Mean density for trees >30 cm dbh in the site series of the MS zone ranged from 75 to 341 stems/ha (Table 4; Figure 18). The ranges for densities of trees >40 cm dbh and >50 cm dbh were 0 to 175 stems/ha and 0 to 88 stems/ha, respectively. Only the 05 site series in the MSdm1 had a density for trees >40 cm dbh of zero (Table 4). The density for trees >30 cm in this site series was 75 stems/ha. As observed above, this was the smallest mean across all site series in the MS zone. The one stand sampled in this site series was primarily lodgepole pine with less than 2% Engelmann spruce (Appendix 2). Also, the total tree density for the stand was 1,724 stems/ha, which was the highest in the zone. Because of the high total tree density and the relatively short life span of lodgepole pine compared to other conifers, it is not too surprising that density of trees >40 cm dbh was zero in this stand. The mean values for trees >40 cm dbh in other site series of the MS zone were greater than 39 stems/ha (Table 4; Figure 18). This value probably reflects the influence of larger and potentially older conifers, such as Douglas-fir, western larch, and Engelmann spruce. For stands comparable to the MS zone, minimal screening criteria for old-growth in western Montana varies from 25 stems/ha for trees >33 cm dbh, where lodgepole pine dominates the stand, to 25 stems/ha for trees >43 cm dbh for stands dominated by subalpine fir, Douglas-fir, and western larch (Green et al. 1992). These values are slightly less than the means found in the MS zone (Table 4). This may reflect lower frequency of stand-destroying fires in the MS zone of the NFR combined with

different mortality rates due to insect and disease in western Montana. Densities for the north-facing stand of Tesch (1981) were calculated to be 170 stems/ha, 52 stems/ha, and 10 stems/ha for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. With the exception of a few stands, including the lodgepole pine stand cited above, the mean values for these densities in the NFR are comparable to or within the range of values found by Tesch (1981). Thus, for the MS zone in the NFR, a zonal criterion for old growth in stands dominated by lodgepole pine could be 75 stems/ha >30 cm. For stands dominated by other conifers, such as Douglas-fir or Engelmann spruce, a zonal criterion of 39 stems/ha >40 cm dbh would be appropriate for old-growth stands.

TABLE 4. BEC stands greater than 140 years old: summary statistics for age, densities, and basal area by site series within variants of the MS zone

Variant	Site series	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
MSdk	01	13	167.4(6.72)[a]	268.8(42.26)	59.1(18.26)	24.0(9.01)	1223.1(230.18)	58.8(4.73)	22.2(1.06)
	03	6	194.6(21.17)	255.0(43.43)	94.2(35.50)	37.9(21.07)	823.1(105.58)	49.7(7.32)	19.1(0.83)
	04	3	160.1(12.52)	302.9(90.29)	123.3(47.04)	25.0(14.65)	811.9(204.28)	56.3(11.41)	23.6(5.30)
	05	3	166.8(15.53)	222.9(29.13)	163.9(41.38)	40.8(10.51)	454.7(141.16)	46.0(2.65)	25.9(4.80)
	06	3	164.9(6.73)	118.5(78.43)	39.1(32.96)	15.5(15.48)	1046.2(188.94)	36.0(8.72)	18.1(2.88)
MSdm1	01	9	157.7(6.59)	170.5(29.57)	62.5(13.75)	31.5(13.78)	763.7(123.08)	42.0(5.53)	21.0(0.86)
	02	1	149.5(-[b])	340.9(-)	48.2(-)	0.0(-)	789.7(-)	55.2(-)	12.4(-)
	04	10	161.3(5.44)	85.2(29.50)	63.3(25.24)	30.1(13.960)	1059.0(215.07)	41.5(2.69)	23.0(1.65)
	05	1	188.5(-)	75.2(-)	0.0(-)	0.0(-)	1724.3(-)	43.7(-)	19.0(-)
	06	4	157.5(9.66)	318.3(81.11)	127.8(39.39)	87.7(31.09)	941.8(439.58)	66.1(11.77)	27.3(4.19)
	07	5	166.7(10.38)	275.1(99.72)	175.4(107.32)	35.0(23.26)	1113.1(278.75)	58.4(13.48)	23.5(4.19)
	08	4	160.3(7.04)	178.0(71.10)	64.2(22.36)	29.6(13.28)	958.4(91.94)	38.0(8.16)	18.6(3.69)

[a] Mean with standard error in brackets.
[b] "-" indicates missing data or value could not be calculated.

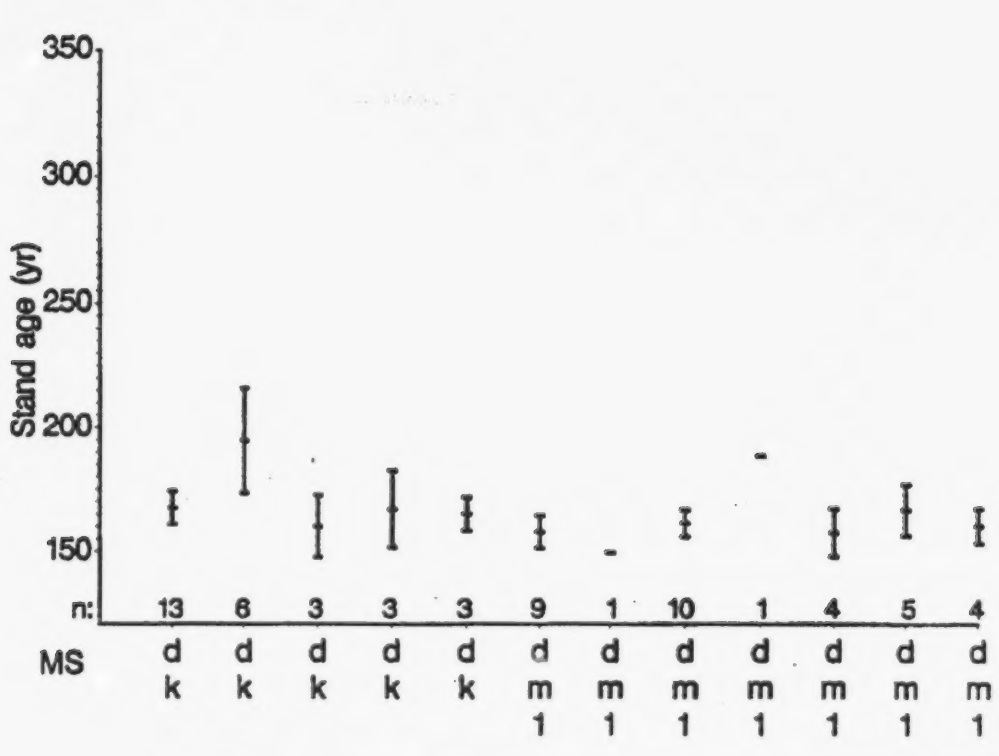

FIGURE 17. Stand ages by site series for the MSdk and MSdm1 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Stick plot and cross bars for each site series indicate mean ± 1 se with n = sample size.

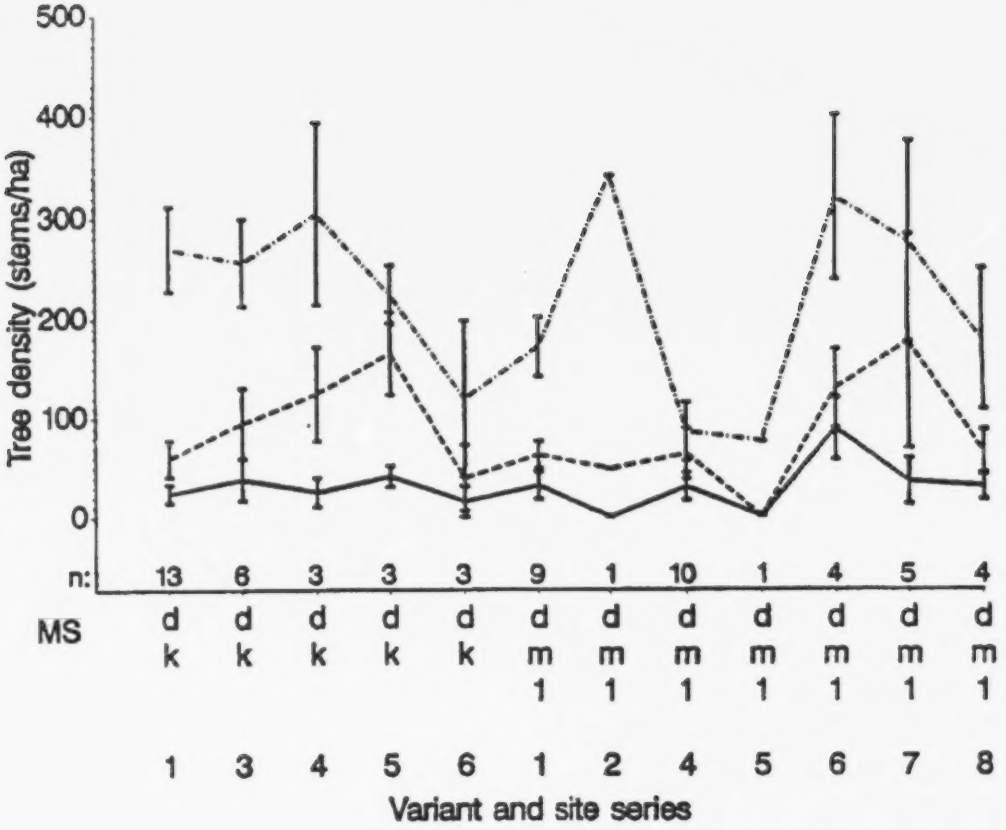
500
400
300
200
100
0
Tree density (stems/ha)
n:
13 6 3 3 3 9 1 10 1 4 5 4
MS
d k d k d k d k d k d m 1 d m 1 d m 1 d m 1 d m 1 d m 1 d m 1
1 3 4 5 6 1 2 4 5 6 7 8
Variant and site series

FIGURE 18. Densities of large-dimension trees by site series in the MSdk and MSdm1 variants. Horizontal axis is labelled with upper 2 or 3 characters for variant and lower character for site series. Plots for each site series indicate mean ± 1 se with n = sample size. Upper, middle, and lower plots are densities for trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, respectively. Means are connected for clarity.

5.1.5 PP Zone

Stands greater than 140 years old were not sampled in the PP zone as part of the BEC sampling program. This zone covers a relatively small area in the NFR and it has been identified as having rare old-growth due to the limited area of age classes 8 and 9 (Quesnel and Leahy 1993). Almost all stands in this zone have been affected by various levels of timber harvesting because of easy access and close proximity to settlement areas. Thus, old-growth stands for comparison are rare in this zone. Zonal criteria for the PP zone in the NFR could be derived from other areas if the stands are considered comparable in terms of tree species composition and stand age. Minimal screening criteria for old-growth stands with a significant component of ponderosa pine have been developed for the northern states. Tree densities of 20 stems/ha >53 cm dbh and a stand age of 150 to 170 years are recommended as minimum for ponderosa pine stands in northern Idaho and western Montana (Green et al. 1992). These stands may include Douglas-fir and western larch. For ponderosa pine and Douglas-fir stands of eastern Washington and Oregon, 25 stems/ha for trees >53 cm dbh and a stand age of 150 years is recommended as minimal screening criteria (Hopkins et al. 1992). Thomas et al. (1979) have suggested snag densities to maintain various percentages of maximum woodpecker populations in the ponderosa pine communities of the Blue Mountains of eastern Oregon and Washington. Examples include 3.2 stems/ha >50.8 cm dbh to maintain 100% pileated woodpeckers and 9.3 to 37.1 stems/ha >30.5 cm dbh for maintaining 100% common flicker and Williamson's sapsucker, respectively. Densities of large trees retained on a site should be greater than these values to allow for other species that use wildlife trees and to allow for snags or large trees not currently being used. Another possibility is to use the densities for the driest site series in the IDF zone and allow for the slightly greater availability of moisture and greater density of larger trees that is likely to occur. The value found for the 03 site series of the IDFdm2 was a mean of 27 stems/ha >50 cm dbh. As noted above, this value is almost identical to the minimal densities recommended in Idaho, Montana, and eastern Washington for stands comparable to the PP zone. As 50 cm dbh has been one of the critical dimensions examined in the BEC data set, a minimal criteria for the PP zone in the NFR could be 25 stems/ha >50 cm dbh. This is slightly smaller than the value for the driest site series sampled in the IDF zone and should partly allow for less moisture in the PP zone and either lower density and/or smaller trees in the PP zone. This stand density is also comparable to mimimal values south of the border. The value recommended here, although lacking sample verification, should be used until either old-

growth stands in this zone are found or stand modelling and simulation studies can project the expected density of larger stand attributes in this zone.

In general, mean stand age within site series, for plots >140 years old sampled in the BEC program, were greater than mimimal values suggested for BEC zones in British Columbia, and for comparable forest types in the United States. Stand ages for some detailed sampling projects were greater than the values found in the BEC program plots. This result may reflect the bias of selecting exceptionally old stands in other projects, the lower minimal stand age used for BEC, the more limited stand aging for the BEC plots, and the difficulty in aging older, hollow-centred trees for species such as western redcedar. Density values for specified minimal tree diameters from the BEC sample plots were usually comparable to data from detailed stand sampling projects in Alberta and the northern states. Also, these density values were generally comparable to minimal screening values recommended in eastern Washington, northern Idaho, and Montana. The minimal screening values for these states were derived from an analysis of mensuration data from extensive surveys. Thus, zonal criteria for BEC zones, based on the lowest values for means of stand ages and tree densities, and within the site series of the zone that are capable of growing old growth, appear to be reasonable. The BEC data can also provide more detailed criteria specific to the site series level. However, limited or a lack of sampling in some site series may create anomalous results for comparison. Users should be aware that some site series were not sampled.

5.2 Stands Sampled In Variants With Rare, Older-Age Classes—Which Are Old-Growth?

Site notes for stands sampled and for additional stands examined but not sampled are included in Appendix 4. The latter stands were not sampled because reconnaissance indicated a BEC variant with relatively large areas of age classes 8 and 9, a lack of old-growth attributes, trees older than 140 years were not found, time or access was limited, or only a helicopter viewing of the stand was possible. As indicated in the site notes, a few of these stands are still considered potential old-growth candidates. Site characteristics for stands examined but not sampled are tabulated in Appendix 5. For the stands sampled, additional data on wildlife observations, tree class, wildlife tree (snag) class, tree species, and tree germinants are included in Appendices 6–10.

The site data for stands sampled are summarized by variant in Table 5. Most of the stands sampled (Figure 4) occurred in the Cranbrook, Invermere, and Boundary forest districts. A few occurred in the Kootenay Lake and Arrow forest districts. Many of the stands occurred on relatively steep areas with shallow to bedrock soils. This is indicated by frequency of colluvium and morainal parent materials (Table 5). Stands on fluvialglacial and fluvial parent materials were sampled less frequently. Low frequency of stands on flatter, lower slopes is probably the result of greater past disturbance. Areas with gentler topography and lower slopes have had extensive disturbance from timber harvesting, land clearing for agriculture, and urban development. Thus, the stands sampled may not completely represent some of these variants because old-growth stands on gentler slopes were not found. The areal extent and occurrence of some units also appear to be more limited than indicated by the GIS maps. There were inaccuracies in the source maps for forest cover and subzone, and recent harvesting had occurred after the maps were published. A good example is the PPdh2 where only two stands >140 years old were found. One of these was marginally acceptable for old growth and not sampled because of limited extent and partial disturbance. These observations indicate an important point. Some of these stands are truly rare and endangered examples of old growth in these variants.

TABLE 5. Site characteristics of stands sampled for old growth

Variant[a]	Site series	Location	Latitude / longitude	Slope gradient (%)	Aspect (°)	Elevation ranges (m)	LFH thickness (cm)	Parent material	Stand age (yr)
ESSFdk	02	Quinn Creek - North	49°57'12" / 115°18'08"	25 - 66	103 - 133	1825 - 1900	2 - 4	colluvium	210
	02 - 04	Quinn Creek - South	49°53'30" / 115°17'15"	45 - 75	110 - 230	1640 - 1685	1 - 3	moraine	162
ESSFwm	02	Angus Creek	49°30'00" / 116°08'58"	55 - 75	298 - 313	1890 - 1930	2 - 6	colluvium	193
ICHdw	01b	Almond 20	49°21'45" / 118°31'15"	7 - 16	72 - 280	1060 - 1090	2 - 2.5	moraine	158
	02 - 01b	Kokanee Creek	49°37'08" / 117°07'00"	26 - 45	174 - 227	940 - 1020	3 - 5	moraine	222
	02	Burrell 18	49°24'00" / 118°26'50"	75 - 92	117 - 125	1008 - 1060	1.5 - 3	colluvium	95
ICHmk1	04	Lodgepole Creek	49°16'55" / 114°46'15"	47 - 60	203 - 265	1500 - 1525	3	colluvium	146
	02	Wigwam River	49°14'08" / 114°57'12"	37 - 75	128 - 216	1100 - 1240	1 - 2	colluvium	134
	05 - 06	Rendell 17	49 49'00" / 118°37'30"	12 - 25	280 - 24	1270 - 1310	1.5 - 4.5	fluvialglacial	203
	06	Parsons 1	51°07'30" / 116°46'20"	1 - 3	30 - 70	790	5 - 6	fluvial	154
ICHmw1	01 - 04	Dogtooth 2	51°05'40" / 116°46'45"	48 - 90	31 - 90	1660 - 1705	2 - 2.5	colluvium, moraine	191

TABLE 5. (continued)

Variant	Site series	Location	Latitude / longitude	Slope gradient (%)	Aspect (°)	Elevation ranges (m)	LFH thickness (cm)	Parent material	Stand age (yr)
ICHmw2	01	Edgewood 34	49°44'40" / 118°16'30"	7 - 22	293 - 152	1390 - 1400	2.5 - 3.5	moraine	322
	01	Granby 32	49°28'10" / 118 35'30"	37 - 38	45 - 55	1450 - 1460	5.5 - 9	moraine	254
	05	Baker Creek	49°36'50" / 116°34'45"	30 - 60	11 - 360	1440 - 1500	7 - 8	colluvium	350
	06	Redding Creek	49°37'00" / 116°30'00"	3 - 20	45 - 95	1300 - 1310	3 - 5	fluvial	150
ICHxw	02	Sanca Creek	49°21'52" / 116°42'58"	63 - 86	236 - 266	630 - 720	0 - 3	colluvium / bedrock	155
IDFdm1	01	Midway 35	49°01'15" / 118°40'20"	12 - 25	275 - 330	1020 - 1060	1 - 1.5	moraine	138
IDFdm2	02	Burton Creek - Southwest	49°19'55" / 115°08'45"	72 - 95	230 - 249	1035 - 1200	0 - 2	colluvium	131
	03	Hahas Lake	49°45'40" / 115°49'45"	35 - 45	90 - 280	1060 - 1080	1	colluvium	183
	03	Perry Creek - North	49°33'08" / 115°58'35"	70 - 78	165 - 191	1030 - 1045	3 - 6	fluvialglacial	135
	01	Perry Creek - South	49°33'00" / 115°58'38"	60 - 98	13 - 353	1045 - 1160	4 - 6	colluvium	177
MSdk	03	Premier Ridge 29	49°04'00" / 115°39'30"	30 - 75	50 - 75	1200 - 1260	1 - 2	colluvium / bedrock	157

TABLE 5. (concluded)

Variant	Site series	Location	Latitude / longitude	Slope gradient (%)	Aspect (°)	Elevation ranges (m)	LFH thickness (cm)	Parent material	Stand age (yr)
MSdk	04	Cartwright Lake 30[b]	50°49'15" / 116°25'40"	2	190	1270	2	moraine	134
MSdm1	04	Rendell Creek - Mouth[c]	49°36'20" / 118°45'15"	50 - 76	282 - 283	1140 - 1250	2.5 - 4	colluvium	160
			49°36'40" / 118°45'30"	45 - 60	284 - 295	920 - 930	2.5 - 4.5	colluvium	
			49°37'30" / 118°45'00"	42	285	850	2.5	fluvialglacial	
PPdh2	02b	Lewis Creek	49°49'35" / 115°41'55"	7 - 20	120 - 210	910 - 930	1 - 3	fluvialglacial	133
	01	Skookumchuck 2	49 56'00"/ 115°46'15"	8 - 14	65 - 280	880 - 890	1 - 2	fluvialglacial	136

[a] Biogeoclimatic units are described in Braumandl and Curran (1992).
[b] Most of this stand was not considered old growth. One large patch with old-growth characteristics was sampled.
[c] This unit consists of three distinct polygons in close proximity.

The tree data for ages, densities, and basal areas (Table 6) were compared to the summary data for the appropriate variant and site series (Tables 1–4; Figures 5–18). For each variable in Table 6, if the value met or exceeded the mean minus one standard error for the corresponding variant and site series in Tables 1–4, the stand was considered to have met the old-growth standard for the ecological unit. The results of these comparisons for seven variables have been summarized and an overall rating for the stand was indicated in the comments (Table 7). Overall, a stand was considered to be old growth if either the stand met the above minimum for stand age or for any of the densities for >30 cm, >40 cm, or >50 cm dbh trees. The densities for larger trees were given greater importance than other variables, such as basal area or total density because of the critical nature of these larger attributes for many wildlife species (Mannan and Meslow 1984; Steeger and Machmer 1995; Thomas et al. 1979).

Five stands met the minimal criterion for all seven variables (Table 7). These stands were located at Rendell 17, Edgewood 34, Granby 32, Baker Creek, and Perry Creek - South. Stands at Cartwright Lake 30 and Wigwam River met all minimal criteria except that the mean stand ages were only 134 to 135 years (Tables 6 and 7). Many trees considerably older were found during the stand reconnaissance of these two stands (Appendix 4). Older trees were also found near but not in the detailed sample plots. The detailed sample plots may simply have landed in relatively young patches within the stand. These stands still met other large attribute minimums. As indicated above, density of larger attributes may be more critical for wildlife species than mean stand age. Thus, these seven stands are considered good examples of old-growth stands in the appropriate variant.

Fifteen other stands are also considered old growth (Table 7). These stands met either the age criterion or one of the large attribute densities, when compared to summary values from the BEC sampling program (Tables 1–4). In this case, both age and densities were considered useful for indicating old-growth stands. Usually, older stands had large living and dead trees, even if they did not always occur at the detailed sample plots. And for some stands with high densities of large trees but a low stand age, older trees were found in other parts of the stand, indicating the detailed sample plots may have been selected in pockets of younger trees. This suggests that either more sample plots per stand should have been measured or perhaps a larger radius plot should have been used for the larger trees.

TABLE 6. Sites sampled for old growth: summary statistics for age, densities, and basal area for each site

Variant	Site series	Location	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
ESSFdk	02	Quinn Creek - North	4	210.2(49.19)[a]	237.5(47.32)	150.0(35.36)	87.5(23.94)	475.0(59.51)	58.3(11.10)	26.3(4.38)
	02-04	Quinn Creek - South	4	162.2(48.48)	175.0(47.87)	37.5(12.50)	0.0(0.00)	712.5(31.46)	36.5(1.86)	20.1(2.23)
ESSFwm	02	Angus Creek	4	192.9(21.37)	162.5(55.43)	87.5(31.46)	25.0(14.43)	875.0(72.17)	38.1(10.19)	19.9(1.82)
ICHdw	01b	Almond Creek	4	157.6(5.26)	287.5(71.81)	137.5(31.46)	12.5(12.50)	1075.0(142.16)	52.5(9.06)	25.2(1.98)
	02-01b	Kokanee Creek	4	222.1(55.23)	250.0(54.01)	125.0(43.30)	100.0(40.82)	712.5(119.68)	61.5(5.32)	36.2(2.54)
	02	Burrell Creek 18	4	95.2(3.09)	81.2(23.66)	50.0(10.21)	12.5(7.22)	168.8(56.25)	14.1(3.53)	23.6(1.29)
ICHmk1	02	Wigwam River	4	134.5(27.04)	150.0(40.82)	87.5(31.46)	37.5(23.94)	612.5(246.96)	38.7(6.61)	20.5(2.84)
	04	Lodgepole Creek	4	146.1(6.44)	225.0(47.87)	75.0(14.43)	0.0(0.00)	1012.5(51.54)	49.9(5.95)	18.6(0.52)
	05-06	Rendell 17	4	202.7(9.17)	362.5(65.75)	200.0(54.01)	112.5(47.32)	887.5(112.50)	80.7(7.22)	28.4(3.09)
	06	Parsons 1	4	154.4(13.93)	337.5(71.81)	125.0(47.87)	12.5(12.50)	962.5(162.50)	57.2(10.54)	23.9(1.70)
ICHmw1	01-04	Dogtooth 2	4	191.2(21.86)	325.0(94.65)	175.0(25.00)	100.0(20.41)	1425.0(156.12)	90.6(5.18)	26.9(0.42)
ICHmw2	01	Edgewood 34	4	321.6(33.40)	325.0(47.87)	275.0(47.87)	187.5(12.50)	700.0(177.95)	98.1(7.15)	24.8(0.95)
	01	Granby 32	2	254.2(0.17)	275.0(25.00)	175.0(25.00)	150.0(0.00)	725.0(225.00)	91.1(14.85)	30.8(0.87)
	05	Baker Creek	4	350.3(41.20)	300.0(45.64)	237.5(59.07)	150.0(28.87)	550.0(61.24)	83.2(19.31)	34.8(2.02)
	06	Redding Creek	4	150.3(20.62)	287.5(42.70)	212.5(42.70)	112.5(42.70)	662.5(74.65)	63.8(9.43)	24.0(4.23)[b]
ICHxw	02	Sanca Creek	4	155.3(27.43)[c]	150.0(58.63)	68.7(25.77)	25.0(17.68)	331.3(104.77)	25.7(9.30)	22.2(2.21)

TABLE 6. (continued)

Variant	Site series	Location	Sample size (n)	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2)	Tree height (m)
IDFdm1	01	Midway 35	4	137.5(15.24)	162.5(51.54)	25.0(25.00)	0.0(0.00)	625.0(14.43)	32.9(6.61)	22.6(1.89)
IDFdm2	01	Perry Creek - South	4	177.1(37.10)	137.5(42.70)	112.5(47.32)	25.0(25.00)	850.0(175.59)	32.5(9.98)	23.4(2.00)
	02	Burton Creek	4	131.0(15.24)	68.7(15.73)	43.7(11.97)	18.8(11.97)	237.5(78.06)	16.3(4.87)	21.5(1.42)
	03	Hahas Lake	4	183.0(21.17)	150.0(33.85)	75.0(10.21)	18.8(6.25)	331.3(31.25)	25.1(3.33)	17.6(0.76)
	03	Perry Creek - North	4	134.7(22.48)	93.7(42.54)	56.2(31.25)	12.5(7.22)	493.8(255.44)	20.5(4.61)	19.1(1.07)
MSdk	03	Premier Ridge 29	4	157.3(15.64)	143.8(21.35)	93.7(25.77)	31.3(11.97)	281.3(41.30)	26.1(3.19)	24.0(0.86)
	04	Cartwright Lake 30	1	134.3(-)[d]	325.0(-)	250.0(-)	225.0(-)	625.0(-)	82.3(-)	22.9(-)
MSdm1	04	Rendell Creek - Mouth	5	159.7(12.26)	80.0(12.25)	150.0(23.72)	75.0(27.39)	640.0(142.87)	46.5(5.42)	24.6(1.96)
PPdh2	01	Skookumchuck 2	4	135.9(6.37)	118.7(27.72)	43.7(15.73)	6.2(6.25)	387.5(38.86)	20.4(2.91)	21.8(1.26)
	02b	Lewis Creek	4	133.0(6.01)	112.5(43.90)	25.0(10.21)	0.0(0.00)	187.5(86.90)	15.2(6.37)	19.7(1.65)

[a] Mean with sampling error in brackets for all mensuration variables.
[b] n = 2 for this variable.
[c] n = 3 for this variable.
[d] "-" indicates missing data or value could not be calculated.

TABLE 7. Rare old-growth stands that meet standards for Nelson Forest Region

Variant	Site series	Location	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2/ha)	Tree height (m)	Comments
ESSFdk	02	Quinn Creek - North	Y[a]	N	Y	Y	N	Y	Y	Old Growth[b]
	02-04	Quinn Creek - South	N[c]	N - Y	N	N	N	N	Y	Old Growth
ESSFwm	02	Angus Creek	N	Y	Y	Y	N	Y	Y	Old Growth
ICHdw	01b	Almond Creek	Y	N	Y	N	Y	N	Y	Old Growth
	02-01b	Kokanee Creek	Y[d]	N	Y	Y	N	N	Y	Old Growth
	02	Burrell Creek 18	N	N	N	N	N	N	Y	-
ICHmk1	02	Wigwam River	N[c]	Y	Y	Y	Y	Y	Y	Old Growth
	04	Lodgepole Creek	N[c]	Y	Y	N	Y	Y	Y	Old Growth
	05-06	Rendell 17	Y	Y	Y	Y	Y	Y	Y	Old Growth
	06	Parsons 1	Y	Y	N	N	Y	N	Y	Old Growth
ICHmw1	01-04	Dogtooth 2	Y	N	N	N	Y	Y	N	Old Growth
ICHmw2	01	Edgewood 34	Y	Y	Y	Y	Y	Y	Y	Old Growth
	01	Granby 32	Y	Y	Y	Y	Y	Y	Y	Old Growth
	05	Baker Creek	Y	Y	Y	Y	Y	Y	Y	Old Growth
	06	Redding Creek	N[c]	Y	Y	Y	Y	N	Y	Old Growth
ICHxw	02	Sanca Creek	N[d]	N	N	Y	N	N	Y	Old Growth
IDFdm1	01	Midway 35	N[c]	Y	N	N	N	N	Y	- Disturbed

TABLE 7. (continued)

Variant	Site series	Location	Stand age (yr)	Tree density >30 cm dbh (stems/ha)	Tree density >40 cm dbh (stems/ha)	Tree density >50 cm dbh (stems/ha)	Tree density Total trees (stems/ha)	Basal area (m^2/ha)	Tree height (m)	Comments
IDFdm2	01	Perry Creek - South	Y	Y	Y	Y	Y	Y	Y	Old Growth
	02	Burton Creek	N[c]	N	N	N	N	N	Y	- Would meet general minimum for IDF of 17 stems/ha >50cm.
	03	Hahas Lake	Y	N	N	N	N	N	Y	Old Growth
	03	Perry Creek - North	N[c]	N	N	N	Y	N	Y	-
MSdk	03	Premier Ridge 29	N[c]	N	Y	Y	N	N	Y	Old Growth
	04	Cartwright Lake 30	N[c]	Y	Y	Y	Y	Y	Y	Old Growth
MSdm1	04	Rendell Creek - Mouth	Y	Y	Y	Y	N	Y	Y	Old Growth
PPdh2	01	Skookumchuck 2	N	Y	N	N	Y	Y	N	Old Growth
	02b	Lewis Creek	N	Y	N	N	Y	Y	N	Old Growth[e]

[a] Y= stand value is equal to or greater than mean - 1 standard error for same variant and site series in Tables 1–4. N=stand value does not meet value calculated for same variant and site series.

[b] Stand meets Nelson Forest Region old-growth standards. Standards are derived from analysis of BEC sample plots >140 years old. The main criteria are stand age and density of large trees or snags. Basal area and total tree density are considered of lesser importance because similar values can be found in stands that are not old growth.

[c] Note that some older trees >200 years old sampled in stand during reconnaissance. These trees were outside sample plots. Plots also had a range of age classes which can characterize some types of old growth.

[d] Values based on comparison with site series with closest moisture conditions.

[e] Best Example Of Ponderosa Pine–Native Grassland Community In Rocky Mountain Trench.

Four stands sampled in detail were not considered old-growth stands because they did not meet minimal criteria for age or densities of larger trees (Tables 6 and 7). These stands were located at Burrell Creek 18, Burton Creek, Midway 35, and Perry Creek - North. The stand at Midway 35 was rejected as old growth because the stand was disturbed (Appendix 4). Larger-diameter trees had been removed by timber harvesting. The stand at Burton Creek would meet the zonal criterion for the IDF zone of 17 stems/ha >50cm suggested in a previous section. Three of these stands had mean ages of greater than 130 years (Table 6). These three stands could be considered as old-growth recruitment patches as part of local or regional planning processes. A second management possibility is to consider retaining patches for wildlife use. All four stands had patches with older or larger trees and snags (Appendix 4). Larger trees and snags have high value for cavity nesters and other species (Mannan and Meslow 1984; Steeger and Machmer 1995). For these four stands, existing dead ranged from 4 to 14%, and live but defective trees which would provide a supply of snag recruits ranged from 8 to 19% (Appendces 7 and 8). These stands also have 78% or greater Douglas-fir (Appendix 9). Larger-diameter dead and defective living trees of this species are important for several local woodpecker species (Steeger and Machmer 1995). A methodology for identifying and establishing wildlife tree patches in forests is being developed and tested operationally in the Arrow Forest District (Steeger et al. 1995).

A special note should be made about the stand at Lewis Creek. It is a good example of a native grass community with ponderosa pine overstory (Appendix 4). It is rare to find this type of stand in the Rocky Mountain Trench, thus the stand at Lewis Creek may be the best example of this community type in the NFR (T. Braumandl, pers. comm., 1992). This is an additional reason to either preserve this stand or to provide special management to maintain its unique characteristics. Active management, including fire, is necessary in this system to maintain the open nature of the stand and to provide suitable conditions for the grasses and other understory species.

One caution when using the standards developed from the BEC sampling program pertains to sample size for a few of the site series. Because only one stand was sampled for some of the site series, the values for the rare stands were compared to the single value for the BEC plots, and a value of the mean minus one standard error could not be calculated. This comparison may be conservative. A rare stand may not meet the old-growth criteria because a single stand from the BEC sampling program may have had an anomalously high value for age or other characteristics. This was noted in a previous

section when the BEC data set was compared to detailed studies from other areas which only sampled a few sites. Good examples of possibly erroneous comparisons include the ages for Quinn Creek - South and Angus Creek (Tables 6 and 7). The age for these two stands was 162 years and 193 years, respectively. These stand ages are both a few decades greater than the minimal screening age of 140 years used in the original GIS process. The BEC data for the site series in these variants (ESSFdk/02; ESSFwm/02) only included one stand (Table 1). The ages for the BEC data sets for these two site series were 179 and 344 years, respectively. The second stand was one of the oldest stands sampled in the BEC program. If additional stands greater than 140 years old had been sampled for the BEC program, it is likely that the mean less the standard error for the ESSFdk/02 would have included the stand age for Quinn Creek - South. Also, the mean minus one standard error for the ESSFwm/02 would have yielded a value closer to if not below the stand age for Angus Creek. These stands are still considered old growth because of other attributes (density of large trees) and they would have easily met the general zonal criterion for the ESSF zone of 41 stems/ha >30cm dbh suggested in a previous section.

A final comment on utility of variables is appropriate. As noted above, stand age and densities of larger trees were given greater weight than variables such as total tree density or tree height. Stands with older ages often have associated old-growth characteristics such as larger trees, snags, and down logs. This is simply a function of greater mortality with stand or individual tree age. Larger trees and snags have high wildlife value, and the presence of these structures should also indicate stands with significant large, down wood. Total tree density is of limited value because young, high-density stands, such as 60-year-old lodgepole pine stands, are quite common in the NFR. These stands could easily meet or beat the total tree density for many of the mean values for the BEC site series without having any large trees or snags. Also, there is probably a maximum tree density beyond which the occurrence of large-diameter trees is curtailed. This can be observed in high-density lodgepole pine stands. These stands have few, if any, large-diameter stems and diameter growth in general is small. Tree height was not considered a critical variable for distinguishing old growth. It is easy to find relatively young trees that are quite tall if it is a favourable growing site. The air photos examined for stands at Grohmann Narrows and Syringa Creek indicated relatively tall trees. These trees appeared to be as tall as those examined on air photos for the Kokanee Creek stand. Ground reconnaissance at both Grohmann Narrows and Syringa Creek indicated large and tall trees that were approximately 100 to 120 years old (Appendices 4 and 5). Both stands lacked snags,

large down logs, and stumps indicating timber harvesting. The large trees were simply the result of rapid growth of open-grown trees on a favourable site. The relatively dry aspects in the ICHdw and IDFun variants, the expected high fire frequency, and a lack of evidence for timber harvesting suggest that these stands were originally open stands of grass, herbs, and shrubs with tree densities of only a few per hectare (Greig Utzig, pers. comm., July 1993). Thus, tree height is a misleading stand attribute unless associated with other variables, such as age or large trees. Basal area was also calculated in this study but not used as a critical attribute for old-growth screening. As with tree density and height, it is easy to envision a thrifty mid-seral stand that could have a basal area comparable to an older stand where increased mortality has reduced the density of trees of specified diameters. In this study, 14 of the stands rated as old growth based on age or density of larger trees had basal areas that would have met the mean minus one standard error for the corresponding BEC unit used as the regional standard (Tables 1–4, 6, 7). However, eight other stands assessed as old growth with the same criteria did not meet the minimal standard for basal area (Table 7). Basal area, although obviously influenced by larger diameter trees, is an attribute that may not always be correlated with other old-growth variables. A possible future relationship to examine would be a multivariate relationship between basal area, total tree density, and other old-growth attributes, such as stand age or density of large trees. A multivariate approach was avoided in this study in order to provide a table lookup approach that would be simpler for inventory purposes. Finally, information on down, woody debris, such as species, size, and state of decay would be useful variables to assess for old-growth stands. Unfortunately, this type of information was not collected for the BEC sampling program and regional standards could not be developed. Data for coarse woody debris was collected for the rare old-growth stands. This data will be analyzed and reported in a separate publication.

5.3 Management Applications

Forest managers and technicians often have to plan and manage for old growth. Old growth needs to be identified for designated old-growth reserves, incorporation in forest ecosystem networks, wildlife tree reserves, and landscape plans where minimal areas of older age classes are an objective of the plan. The following illustrates how a forest manager or technician might utilize this report and the data summaries to inventory and manage for old growth.

The first step is to specify, at the appropriate planning level, the proportion of a potential old-growth area that should meet the minimal structural attributes. This will allow for

younger patches that occur naturally in old-growth stands. It may be necessary to map a few known old-growth stands in detail to determine the age-class distribution within the stand, and specifically, what the minimum proportion is of older age classes in the stand. Detailed cruising information may provide suitable stand-specific, age-class distributions. An alternative method is to consult local wildlife biologists, or studies that specify density of trees or snags necessary to maintain some of the local species in old-growth stands. Good examples are contained in Thomas et al. (1979). This study presents various densities required to maintain percentages of maximum woodpecker populations.

The second step is to obtain detailed inventory data for the stand at a scale of 1:20 000 or larger. In some cases, ages plus counts of trees and snags greater than minimum size may provide a quick and adequate assessment of the stand. Data for local cavity nesters, ungulates, or other species could also be gathered and correlated with the tree inventory.

The third step is to compare the stand data with the standards developed from the BEC sample data (Tables 1–4). The user should calculate mean minus one standard error for the appropriate attribute in Tables 1–4 and compare these values with the stand data. The main variables to use are age and densities of trees >30 cm dbh, >40 cm dbh, and >50 cm dbh, as applicable for the variant. If sample size is small (n<3?), use the general zonal criteria suggested in Section 5.1. If the site series was not sampled as part of the BEC program, use either the closest site series in terms of moisture status, or the zonal criteria suggested in Section 5.1. Sometimes the user may have to go to another variant to obtain the standard. In this case, use the BEC unit with the closest moisture regime. For example, old-growth summary data is not available for the PP zone. A stand in the 04 site series of the PPdh1 could be evaluated for old growth by using the summary data for the 03 site series of the IDFdm1 (Table 3). These two site series are similar in terms of tree, shrub, and herb cover (Braumandl and Curran 1992).

The final step is to use the stand data plus old-growth ratings to plan and manage the stand or to reject the stand if it does not meet any minimal standard. The stand may have to be retained and managed as an old-growth recruitment area if areal requirements are not met and older stands are not available. The minimal standards could then be used for setting management targets in terms of stand attributes. The user should aim to meet at least the minimum standards for old-growth attributes and preferably exceed these values. In particular, larger-diameter trees have greater and longer-lasting wildlife value. These trees also provide much of the esthetic appeal of old-growth stands for humans. Therefore, trees much greater than 50 cm are desirable and recommended. Old-growth

management does not preclude all timber harvesting. Thinning of small-diameter trees may be desirable to accelerate the growth of the remaining trees and thus shorten the time required to achieve the desired sizes. In some cases, specific tree species or tree classes will be of interest. Appendices 2 and 3 should be consulted for average values for these attributes found in the BEC sampling program. An old-growth stand should contain some of the tree species listed in Appendix 2. The above procedure is similar to and should be compatible with suggested methods for wildlife tree management (Hunter 1990; Steeger et al. 1995; Thomas et al. 1979).

Use of summary statistics would have to be adjusted for possible alterations in stand structure caused by human activities that modify disturbance frequency or intensity. This includes fire suppression, widespread pesticide applications, and treatments for pathogens. For example, tree species composition and density of smaller stems are probably altered in BEC units, such as the PP zone, where active fire suppression programs are underway. Thus, data collected from existing stands may not always represent the historic condition for fire-maintained ecosystems. Also, current stands will not reflect changes in future stand development and condition that result from climate modification by nature or human activity.

6 SUMMARY AND CONCLUSIONS

The BEC sampling program provided mensuration data for almost 400 plots greater than 140 years old in the NFR. The plots covered most site series within variants across this administrative unit. Summary statistics for this data set were limited because there were no plots in the PP zone, and a few site series from other zones either lacked data or only had a few plots. In general, the data set provided good coverage for most of the ecological units; useful old-growth criteria could be developed to the site series level for many variants, and where site-specific criteria were not possible, general zone level criteria could be suggested. Zonal criteria based on the density of trees >50 cm dbh for the PP and IDF zones would be 25 and 17 stems/ha, respectively. For the ICH zone, the density for trees of the same minimal diameter would yield a zonal criterion of 36 stems/ha for the drier variants and 60 stems/ha for the wetter variants. Zonal criteria based on the density of trees >30 cm dbh for the ESSF zone, and for the MS zone with stands dominated by lodgepole pine, would be 41 and 75 stems/ha, respectively. Density of trees >40 cm dbh also yield zonal criterion for the IDF zone, and for the MS zone with stands not dominated by lodgepole pine, of 58 and 39 stems/ha, respectively. Summaries of the BEC plot data also provide baseline information on tree class and tree species composition. Tree class

and species data were not evaluated for criteria purposes. This data has been summarized and could be used to estimate probable characteristics of stands in a specific site series.

Twenty-six stands were sampled in detail for BEC units identified by GIS as having limited areas of forests >140 years old. Twenty-two of these stands were rated as rare old-growth stands when compared to mensuration criteria developed from the BEC data set. The criteria used included age and density of larger living or dead trees. Total tree density, basal area, and tree height were considered less useful as potential old-growth criteria. Values for these latter criteria could easily be found in younger stands without old-growth attributes important to wildlife. Four additional stands had detailed sampling but did not meet the minimal screening criteria. Thirty-eight stands were examined but not sampled because the reconnaissance indicated a lack of old-growth attributes, the BEC unit was not identified as rare by the GIS project, limited access or time prevented detailed sampling, or only helicopter viewing was possible. A few of these are still considered potential old-growth stands that require detailed stand sampling if the land use of the stand becomes an issue. Notes and summary information were compiled for both the stands with detailed sampling and other stands examined for rare old-growth.

Management application of the old-growth criteria developed in this study is briefly discussed. Summary statistics for the BEC data sets can be used as standards for evaluating and mapping potential old-growth stands. These standards could also be used for setting management targets where old-growth recruitment is required.

APPENDIX 1 SUBZONE/VARIANT NAMES, TREE SPECIES, AND ELEVATION RANGES FOR BIOGEOCLIMATIC UNITS[a]

Biogeo-climatic zone	Climate region	Abbrevi-ation	Subzone/ variant	Tree species[b]	Elevation ranges[c]
PP Ponderosa Pine	Dry	PPdh1	Kettle Dry Hot Ponderosa Pine Variant	**Py, Fd** At, Ac, Sxw, (Lw[d]), [-Pl[e]]	S: 500-950 m
	Dry	PPdh2	Kootenay Dry Hot Ponderosa Pine Variant	**Py, Fd** Sxw, At, Ac, (Lw, Pl)	S: 700-950 m
IDF Interior Douglas-fir	Dry	IDFxh1[f]	Okanagan Very Dry Hot Interior Douglas-fir Variant	**Fd, Py** At, Ep, (Lw) [-Pl]	S: 500-1200 m N: 500-1050 m
	Dry	IDFun	Undifferentiated Interior Douglas-fir Subzone	**Fd**	
	Dry	IDFdm1	Kettle Dry Mild Interior Douglas-fir Variant	**Fd** Lw, Pl, Py, Sxw, At, Ac, Ep, (Cw)	S: 500-1370 m N: 500-1280 m
	Dry	IDFdm2	Kootenay Dry Mild Interior Douglas-fir Variant	**Fd** Py, Lw, Pl, Sxw, At, Ac, (Ep)	S: 800-1200 m N: 800-1100 m
ICH Interior Cedar–Hemlock	Moist	ICHxw	Very Dry Warm Interior Cedar–Hemlock Subzone	**Cw, Bg** Lw, Fd, Pl, Py, Sxw, At, Ac, Ep, Bl, Hw, Pw	S: 450-1100 m
	Moist	ICHdw	Dry Warm Interior Cedar–Hemlock Subzone	**Hw, Cw, Ac, (Bl)** Lw, Fd, Pl, Py, Sxw, Pw, Bg, Ep, At	S: 450-1200 m N: 450-1000 m
	Moist	ICHmw1	Golden Moist Warm Interior Cedar–Hemlock Variant	**Hw, Cw** Fd, Pl, Sxw, Pw, Ep, Ac, (Bl), [-Lw]	S: 750-1550 m N: 750-1500 m
	Moist	ICHmw2[g]	Columbia-Shuswap Moist Warm Interior Cedar–Hemlock Variant	**Hw, Cw** Fd, Pl, Pw, Sxw, At, Lw, Ac, Ep, Bl, [-Bg, -Py]	S: 500-1450 m N: 500-1400 m
	Moist	ICHmw3[f]	Thompson Moist Warm Interior Cedar–Hemlock Variant	**Hw, Cw** Fd, Pl, Pw, Sxw, Bl, At, Ep, Ac, [-Lw]	S: 400-1400 m N: 400-1350 m
	Moist	ICHmk1	Kootenay Moist Cool Interior Cedar–Hemlock Variant	**Cw, Sxw** Lw, Fd, Pl, Py, Ep, At, Ac, Bl, (Pw, Hw)	S: 800-1550 m N: 750-1500 m

Appendix 1 (continued)

Biogeoclimatic zone	Climate region	Abbreviation	Subzone/variant	Tree species[b]	Elevation ranges[c]
ICH Interior Cedar–Hemlock	Wet	ICHwk1	Wells Gray Wet Cool Interior Cedar–Hemlock Variant	**Hw, Cw** Fd, Bl, Sxw, Ep, Ac, Pw, (Lw, Pl, At)	S: 400-1400 m N: 400-1350 m
	Wet	ICHvk1	Mica Very Wet Cool Interior Cedar–Hemlock Variant	**Hw, Cw** Fd, Pw, Sxw, Ep, Ac, (Bl, At), [-Pl, -Lw]	S: 550-1350 m N: 550-1350 m
MS Montane Spruce	Dry	MSdk	Dry Cool Montane Spruce Subzone	**Se, Bl, (Fd)** Fd, Pl, Lw, At, Ac, Ep, (Sw, Cw)	S: 1200-1650 m N: 1100-1550 m
	Dry	MSdm1	Okanagan Dry Mild Montane Spruce Variant	**Se, Bl, (Fd)** Ac, Ep, (Sw)	S: 1370-1650 m N: 1280-1550 m
ESSF Engelmann Spruce–Subalpine Fir	Dry	ESSFdk	Dry Cool Engelmann Spruce–Subalpine Fir Subzone	**Se, Bl,** Pa, Pl, La, At, (Fd^h, Lw^h)	S: 1650-2100 m N: 1550-2100 m
	Dry	ESSFdkp	Dry Cool Parkland Engelmann Spruce–Subalpine Fir Subzone	**Se, Bl** Pa, La	S: 2100-2600 m N: 2100-2600 m
	Dry	ESSFdcl	Okanagan Dry Cold Engelmann Spruce–Subalpine Fir Variant	**Se, Bl** Pl, (Pa, At)	S: 1650-1950 m N: 1550-1950 m
	Moist	ESSFwm	Wet Mild Engelmann Spruce–Subalpine Fir Subzone	**Bl, Se** (Hw, Pw, Pl, Lw)	S: 1600-1950 m N: 1500-1950 m
	Moist	ESSFwmp	Wet Mild Parkland Englemann Spruce–Subalpine Fir Subzone	**Bl, Se** Pa, La	S: 1950-2600 m N: 1950-2600 m
	Moist, Wet	ESSFwc1	Columbia Wet Cold Engelmann Spruce–Subalpine Fir Variant	**Se, Bl** Hw, Cw, Pl, (Fd, Pw, Lw, Pa)	S: 1450-1650 m N: 1400-1600 m
	Moist, Wet	ESSFwc2[f]	Northern Monashee Wet Cold Engelmann Spruce–Subalpine Fir Variant	**Se, Bl** Pl ($Fd)^h$	S: 1450-1800 m N: 1400-1800 m
	Moist, Wet	ESSFwc4	Selkirk Wet Cold Engelmann Spruce–Subalpine Fir Variant	**Se, Bl** Pl, Pa	S: 1650-1950 m N: 1600-1950 m

Appendix 1 (concluded.)

Biogeo-climatic zone	Climate region	Abbrevi-ation	Subzone/ variant	Tree species[b]	Elevation ranges[c]
ESSF Engelmann Spruce–Subalpine Fir	Moist, Wet	ESSFwcp	Wet Cold Parkland Englemann Spruce–Subalpine Fir Subzone	**Se, Bl** La, Pa	S: 1950-2440 m N: 1950-2400 m
	Wet	ESSFvc	Very Wet Cold Engelmann Spruce–Subalpine Fir Subzone	**Se, Bl, Hm** (Cw[h], Hw[h])	S: 1350-1800 m N: 1250-1800 m
	Wet	ESSFvcp	Very Wet Cold Parkland Engelmann Spruce–Subalpine Fir Subzone	**Se, Bl, Hm** Pa	S: 1800-2300 m N: 1800-2300 m
AT Alpine Tundra	Dry, Moist, Wet	AT			Min. Elev. 2600 m in Dry Region; 2400 m in Moist Region; 2300 m in Dry Region

[a] Table extracted from Braumandl and Curran (1992).

[b] Species in bold are zonal climax, all non-bold species are seral or non-zonal species. Ac=*Populus balsamifera* ssp. *trichocarpa*, At=*Populus tremuloides*, Bg=*Abies grandis*, Bl=*Abies lasiocarpa*, Cw=*Thuja plicata*, Ep=*Betula papyrifera*, Fd=*Pseudotsuga menziesii*, Hm=*Tsuga mertensiana*, Hw=*Tsuga heterophylla*, La=*Larix lyallii*, Lw=*Larix occidentalis*, Pa=*Pinus albicaulis*, Pl=*Pinus contorta*, Pw=*Pinus monticola*, Py=*Pinus ponderosa*, Se=*Picea engelmannii*, Sxw=*Picea glauca* x *engelmannii*, Sw=*Picea glauca*.

[c] S=south aspect, N=north aspect.

[d] ( ) Bracketed species are rare species.

[e] [-] Square brackets and minus sign denote diagnostic absence of species.

[f] Please refer to Kamloops Forest Region Fieldguide (Lloyd et al. 1990) for site identification and management interpretations for the IDFxh1, ICHmw3, and ESSFwc2. These variants are of limited extent in the Nelson Forest Region.

[g] The southern portion of this variant is found above the ICHdw, i.e., at elevations of 1200-1550 m.

[h] Occur in the lower elevations of the subzone/variant.

APPENDIX 2 BEC STANDS GREATER THAN 140 YEARS OLD: FREQUENCY OF TREE SPECIES BY SITE SERIES WITHIN VARIANTS

This appendix contains a statistical output from SAS. Mean refers to average density of trees >7.5 cm dbh within a site series. The frequency of a tree species within a site series is indicated by "%". Number of stands sampled (n) is indicated in Tables 1–4 of the main text.

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=ESSFdc1 ----------

Tree species

Site series		Abies lasiocarpa stems/ha	Pinus albicaulis stems/ha	Pinus contorta stems/ha	Picea engelmannii stems/ha
1	mean	515.7	4.5	371.3	288.3
	%	43.7	0.6	31.5	24.4
3	mean	455.1	.	819.6	247.8
	%	29.9	.	53.8	16.3
4	mean	253.0	.	279.7	570.3
	%	22.9	.	25.4	51.7
5	mean	464.7	.	196.0	476.1
	%	40.9	.	17.2	41.9
6	mean	529.9	.	172.5	264.4
	%	54.8	.	17.8	27.3

---------- VARIANT=ESSFdk ----------

Tree species

Site series		Abies lasiocarpa stems/ha	Thuja plicata stems/ha	Pseudotsuga menziesii stems/ha	Pinus albicaulis stems/ha	Pinus contorta stems/ha	Picea engelmannii stems/ha
1	mean	654.1	.	.	.	.	140.5
	%	82.3	.	.	.	.	17.7
2	mean	.	.	625.0	.	232.7	.
	%	.	.	72.9	.	27.1	.
3	mean	351.6	7.8	37.1	.	362.7	609.7
	%	25.7	0.6	2.7	.	26.5	44.5
4	mean	372.7	.	.	16.5	531.3	520.3
	%	25.9	.	.	1.1	36.9	36.1
5	mean	1165.6	.	.	.	458.5	729.7
	%	49.5	.	.	.	19.5	31.0
6	mean	566.4	.	.	.	.	221.9
	%	71.8	.	.	.	.	28.2

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=ESSFdkp ----------

Site series		Tree species: Larix lyallii, stems/ha
0	mean	486.5
	%	100.0

---------- VARIANT=ESSFvc ----------

Site series		Tree species: Abies lasiocarpa, stems/ha	Tsuga mertensiana, stems/ha	Tsuga heterophylla, stems/ha	Picea engelmannii, stems/ha
1	mean	363.5	93.6	22.5	51.7
	%	68.4	17.6	4.2	9.7
2	mean	271.8	1070.0	.	17.0
	%	20.0	78.7	.	1.3
3	mean	624.1	62.7	.	127.8
	%	76.6	7.7	.	15.7
4	mean	216.0	.	.	199.8
	%	51.9	.	.	48.1
5	mean	174.8	89.2	.	160.0
	%	41.2	21.0	.	37.7
6	mean	509.7	334.2	.	8.1
	%	59.8	39.2	.	1.0

---------- VARIANT=ESSFvcp ----------

Site series		Tree species: Abies lasiocarpa, stems/ha	Tsuga mertensiana, stems/ha	Picea engelmannii, stems/ha
0	mean	1036.3	86.6	62.7
	%	87.4	7.3	5.3

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=ESSFwc1 ----------

Site series		Tree species: Abies lasiocarpa stems/ha	Thuja plicata stems/ha	Tsuga heterophylla stems/ha	Pinus contorta stems/ha	Picea engelmannii stems/ha
1	mean	231.7	.	45.4	42.9	252.6
	%	40.5	.	7.9	7.5	44.1
2	mean	451.0	.	251.1	.	314.7
	%	44.4	.	24.7	.	30.9
3	mean	132.3	7.2	.	.	304.0
	%	29.8	1.6	.	.	68.5
4	mean	88.7	.	.	.	190.0
	%	31.8	.	.	.	68.2
5	mean	538.8	.	.	.	422.1
	%	56.1	.	.	.	43.9

---------- VARIANT=ESSFwc2 ----------

Site series		Tree species: Abies lasiocarpa stems/ha	Picea engelmannii stems/ha
1	mean	362.5	175.8
	%	67.3	32.7
4	mean	729.3	29.5
	%	96.1	3.9
5	mean	299.0	286.1
	%	51.1	48.9

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=ESSFwc4 ----------

Site series		Tree species: Abies lasiocarpa stems/ha	Tsuga mertensiana stems/ha	Tsuga heterophylla stems/ha	Pinus albicaulis stems/ha	Pinus contorta stems/ha	Picea engelmannii stems/ha
1	mean	444.2	.	.	.	1.2	121.6
	%	78.3	.	.	.	0.2	21.4
2	mean	885.5	.	18.3	26.7	.	384.9
	%	67.3	.	1.4	2.0	.	29.3
3	mean	967.4	.	.	.	.	189.3
	%	83.6	.	.	.	.	16.4
4	mean	733.7	36.2	.	0.9	.	178.8
	%	77.3	3.8	.	0.1	.	18.8
5	mean	163.6	.	.	.	.	164.4
	%	49.9	.	.	.	.	50.1
7	mean	240.1	.	.	.	.	323.7
	%	42.6	.	.	.	.	57.4
8	mean	281.7	.	.	.	110.6	222.6
	%	45.8	.	.	.	18.0	36.2

---------- VARIANT=ESSFwcp ----------

Site series		Tree species: Abies lasiocarpa stems/ha	Picea engelmannii stems/ha
0	mean	136.1	80.5
	%	62.8	37.2

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

VARIANT=ESSFwm

Site series		Tree species: Abies lasiocarpa stems/ha	Tsuga heterophylla stems/ha	Pinus albicaulis stems/ha	Picea engelmannii stems/ha
1	mean	636.6	.	.	322.8
	%	66.4	.	.	33.6
2	mean	456.0	.	63.7	386.7
	%	50.3	.	7.0	42.7
3	mean	76.6	134.5	.	90.0
	%	25.4	44.7	.	29.9
4	mean	668.7	.	.	402.3
	%	62.4	.	.	37.6

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=ICHdw ----------

Site series		Tree species: Populus trichocarpa stems/ha	Abies grandis stems/ha	Abies lasiocarpa stems/ha	Thuja plicata stems/ha	Betula papyrifera stems/ha	Pseudotsuga menziesii stems/ha	Tsuga heterophylla stems/ha
1A	mean	.	.	51.3	166.4	.	109.3	517.6
	%	.	.	5.9	19.3	.	12.7	59.9
1B	mean	.	.	.	141.2	.	16.2	868.6
	%	.	.	.	11.8	.	1.3	72.4
3	mean	3.7	30.9	.	365.1	9.7	111.5	174.8
	%	0.4	3.5	.	40.9	1.1	12.5	19.6

Site series		Tree species: Larix occidentalis stems/ha	Pinus contorta stems/ha	Pinus monticola stems/ha	Picea glauca x engelmannii stems/ha
1A	mean	.	.	19.5	.
	%	.	.	2.3	.
1B	mean	33.5	103.2	37.3	.
	%	2.8	8.6	3.1	.
3	mean	.	.	.	197.5
	%	.	.	.	22.1

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

VARIANT=ICHmk1

Tree species

Site series		Populus trichocarpa	Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Larix occidentalis	Pinus contorta	Picea glauca x engelmannii
		stems/ha	stems/ha	stems/ha	stems/ha	stems/ha	stems/ha	stems/ha
1	mean	.	132.5	65.5	15.7	56.8	223.5	414.9
	%	.	14.6	7.2	1.7	6.2	24.6	45.7
3	mean	.	.	.	248.0	.	505.4	.
	%	.	.	.	32.9	.	67.1	.
4	mean	.	234.6	.	238.0	30.3	382.0	291.0
	%	.	20.0	.	20.2	2.6	32.5	24.7
5	mean	26.5	112.7	13.4	7.6	.	46.9	363.9
	%	4.6	19.7	2.3	1.3	.	8.2	63.7
6	mean	.	286.9	283.3	.	.	.	223.5
	%	.	36.1	35.7	.	.	.	28.2

VARIANT=ICHmw1

Tree species

Site series		Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Tsuga heterophylla	Picea glauca x engelmannii
		stems/ha	stems/ha	stems/ha	stems/ha	stems/ha
1	mean	19.4	195.6	.	320.6	8.0
	%	3.6	36.0	.	59.0	1.5
5	mean	69.6	529.3	.	144.5	.
	%	9.4	71.2	.	19.4	.
6	mean	155.9	228.6	5.6	253.9	17.1
	%	23.6	34.6	0.8	38.4	2.6

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

VARIANT=ICHmm2

Tree species

Site series		Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Tsuga heterophylla	Larix occidentalis	Pinus monticola	Picea glauca x engelmannii
		stems/ha	stems/ha	stems/ha	stems/ha	stems/ha	stems/ha	stems/ha
1	mean	16.8	78.1	4.1	403.0	6.6	3.4	17.7
	%	3.2	14.7	0.8	76.1	1.2	0.6	3.3
3	mean	.	37.3	.	393.0	.	.	.
	%	.	8.7	.	91.3	.	.	.
4	mean	6.4	214.8	18.1	495.4	8.0	.	6.2
	%	0.9	28.7	2.4	66.2	1.1	.	0.8
5	mean	55.4	121.6	1.0	193.9	4.2	.	19.1
	%	14.0	30.8	0.2	49.1	1.1	.	4.8
6	mean	122.4	173.2	2.6	333.2	1.0	3.9	60.3
	%	17.6	24.9	0.4	47.8	0.1	0.6	8.7

VARIANT=ICHvk1

Tree species

Site series		Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Tsuga heterophylla	Pinus monticola	Picea glauca x engelmannii
		stems/ha	stems/ha	stems/ha	stems/ha	stems/ha	stems/ha
1	mean	.	141.2	.	243.7	0.5	23.2
	%	.	34.6	.	59.6	0.1	5.7
3	mean	151.8	78.9	.	341.6	.	1.6
	%	19.6	10.2	.	70.0	.	0.2
4	mean	.	114.5	3.9	506.0	7.4	.
	%	.	18.1	0.6	80.1	1.2	.
5	mean	.	140.2	.	48.8	.	27.1
	%	.	64.9	.	22.6	.	12.5
6	mean	40.5	180.0	.	207.7	4.5	80.1
	%	7.9	35.1	.	40.5	0.9	15.6

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=ICHwk1 ----------

Site series		Tree species: Populus tricho-carpa stems/-ha	Abies lasioc-arpa stems/-ha	Thuja plicata stems/-ha	Pseudo-tsuga menzie-sii stems/-ha	Tsuga hetero-phylla stems/-ha	Pinus contor-ta stems/-ha	Pinus montic-ola stems/-ha
1	mean	.	123.2	135.8	.	354.3	.	3.9
	%	.	18.6	20.5	.	53.6	.	0.6
4	mean	.	15.9	102.9	7.0	594.4	.	2.1
	%	.	2.2	14.0	1.0	80.9	.	0.3
5	mean	1.0	31.7	148.0	0.3	76.8	.	2.3
	%	0.3	10.2	47.5	0.1	24.6	.	0.7
6	mean	.	75.5	.	.	28.8	60.9	.
	%	.	20.9	.	.	8.0	16.9	.
8	mean	.	.	132.5	.	237.7	.	.
	%	.	.	32.8	.	58.8	.	.

Site series		Tree species: Picea glauca x engelmannii stems/-ha
1	mean	44.0
	%	6.7
4	mean	12.9
	%	1.7
5	mean	51.6
	%	16.6
6	mean	196.1
	%	54.3
8	mean	34.1
	%	8.4

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

VARIANT=IDFdm1

Tree species

Site series		Populus tricho-carpa	Abies lasioc-arpa	Thuja plicata	Betula papyri-fera	Pseudo-tsuga menzie-sii	Larix occide-ntalis	Pinus contor-ta
		stems/-ha	stems/-ha	stems/-ha	stems/-ha	stems/-ha	stems/-ha	stems/-ha
1	mean	.	42.7	.	.	447.6	258.1	433.8
	%	.	3.6	.	.	37.9	21.8	36.7
3	mean	.	.	.	.	192.4	.	.
	%	.	.	.	.	53.6	.	.
4	mean	.	17.2	1.3	.	425.2	222.7	.
	%	.	2.5	0.2	.	62.9	32.9	.
5	mean	.	.	.	216.1	379.0	341.0	.
	%	.	.	.	23.1	40.5	36.4	.
6	mean	37.3	.	.	.	.	.	.
	%	24.9	.	.	.	.	.	.

Tree species

Site series		Pinus ponder-osa	Picea glauca x engela-nnii
		stems/-ha	stems/-ha
1	mean	.	.
	%	.	.
3	mean	166.5	.
	%	46.4	.
4	mean	9.8	.
	%	1.5	.
5	mean	.	.
	%	.	.
6	mean	.	112.2
	%	.	75.1

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=IDFdm2 ----------

		Tree species			
		Pseudotsuga menziesii	Larix occidentalis	Pinus contorta	Pinus ponderosa
		stems/ha	stems/ha	stems/ha	stems/ha
Site series					
1	mean	97.7	113.4	220.9	116.4
	%	17.8	20.7	40.3	21.2
3	mean	374.6	.	.	.
	%	100.0	.	.	.

---------- VARIANT=IDFun ----------

		Tree species
		Pinus ponderosa
		stems/ha
Site series		
0	mean	58.3
	%	100.0

Appendix 2 (continued)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

---------- VARIANT=MSdk ----------

Site series		Populus trichocarpa stems/ha	Abies lasiocarpa stems/ha	Betula papyrifera stems/ha	Pseudotsuga menziesii stems/ha	Larix occidentalis stems/ha	Pinus contorta stems/ha	Picea engelmannii stems/ha
1	mean	5.2	124.5	21.1	80.2	2.4	332.8	343.3
	%	0.4	10.2	1.7	22.9	0.2	27.2	28.1
3	mean	.	.	.	620.2	.	93.1	50.0
	%	.	.	.	75.4	.	11.3	6.1
4	mean	.	.	.	567.8	125.5	118.6	.
	%	.	.	.	69.9	15.5	14.6	.
5	mean	.	134.1	.	46.7	75.1	.	198.8
	%	.	29.5	.	10.3	16.5	.	43.7
6	mean	.	119.5	57.4	.	.	10.8	464.6
	%	.	11.4	5.5	.	.	1.0	44.4
					.			

Site series		Tree species: Picea glauca x engelmannii stems/ha
1	mean	113.7
	%	9.3
3	mean	59.8
	%	7.3
4	mean	.
	%	.
5	mean	.
	%	.
6	mean	394.0
	%	37.7

Appendix 2 (concluded.)

Tree species frequency by variant and site series
14:16 Tuesday, November 28, 1995

VARIANT=MSdm1

Site series		Tree species					
		Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Larix occidentalis	Pinus contorta	Picea engelmannii
		stems/ha	stems/ha	stems/ha	stems/ha	stems/ha	stems/ha
1	mean	240.3	21.0	28.2	24.0	159.8	290.4
	%	31.5	2.8	3.7	3.1	20.9	38.0
2	mean	.	.	789.7	.	.	.
	%	.	.	100.0	.	.	.
4	mean	.	.	91.2	67.6	890.1	10.0
	%	.	.	8.6	6.4	84.1	0.9
5	mean	.	.	.	.	1697.9	26.4
	%	.	.	.	.	98.5	1.5
6	mean	.	.	107.8	55.2	.	778.7
	%	.	.	11.5	5.9	.	82.7
7	mean	499.0	.	31.9	.	.	582.2
	%	44.8	.	2.9	.	.	52.3
8	mean	450.5	.	.	.	112.5	395.4
	%	47.0	.	.	.	11.7	41.3

APPENDIX 3 BEC STANDS GREATER THAN 140 YEARS OLD: FREQUENCY OF TREE CLASSES BY SITE SERIES WITHIN VARIANTS

This appendix contains a statistical output from SAS. Mean refers to average density of trees >7.5 cm dbh within a site series. The frequency of a tree class within a site series is indicated by "%". Number of stands sampled (n) is indicated in Tables 1–4 of the main text. Tree classes are described in B.C. Min. Forests (1992d).

Appendix 3 (continued)

Tree class frequency by variant and site series
13:38 Monday, May 15, 1995

Variant	Site series		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha	Veteran stems/ha
ESSF-dc1	1	mean	480.5	575.8	83.7	39.8	.
		%	40.7	48.8	7.1	3.4	.
	3	mean	538.1	743.1	90.2	151.2	.
		%	35.3	48.8	5.9	9.9	.
	4	mean	592.9	343.1	36.9	130.1	.
		%	53.8	31.1	3.3	11.8	.
	5	mean	575.7	483.9	23.0	54.1	.
		%	50.6	42.6	2.0	4.8	.
	6	mean	456.9	502.8	7.1	.	.
		%	47.3	52.0	0.7	.	.
ESSF-dk	1	mean	518.2	162.7	2.2	113.4	.
		%	65.0	20.5	0.3	14.3	.
	2	mean	264.4	421.2	.	172.2	.
		%	30.8	49.1	.	20.1	.
	3	mean	624.1	411.7	10.1	323.0	.
		%	45.6	30.1	0.7	23.6	.
	4	mean	499.1	733.8	98.6	89.0	20.3
		%	34.6	50.9	6.8	6.2	1.4
	5	mean	798.6	1368.0	.	187.2	.
		%	33.9	58.1	.	8.0	.
	6	mean	394.5	387.7	.	6.2	.
		%	50.0	49.2	.	0.8	.
ESSF-dkp	0	mean	290.1	196.4	.	.	.
		%	59.6	40.4	.	.	.
ESSF-vc	1	mean	174.6	346.5	10.3	.	.
		%	32.8	65.2	1.9	.	.
	2	mean	1005.9	342.0	.	11.0	.
		%	74.0	25.2	.	0.8	.
	3	mean	369.9	444.7	.	.	.
		%	45.4	54.6	.	.	.
	4	mean	207.7	169.6	25.6	12.9	.
		%	49.9	40.8	6.2	3.1	.
	5	mean	90.1	328.2	.	5.7	.
		%	21.2	77.4	.	1.3	.
	6	mean	350.9	501.1	.	.	.
		%	41.2	58.8	.	.	.
ESSF-vcp	0	mean	257.6	832.8	95.2	.	.
		%	21.7	70.2	8.0	.	.
ESSF-wc1	1	mean	125.1	407.1	10.7	29.6	.
		%	21.8	71.1	1.9	5.2	.

Appendix 3 (continued)

Tree class frequency by variant and site series
13:38 Monday, May 15, 1995

Variant	Site series		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha	Veteran stems/ha
ESSF-wc1	2	mean	621.6	231.6	30.4	133.2	.
		%	61.1	22.8	3.0	13.1	.
	3	mean	107.2	282.9	.	53.4	.
		%	24.2	63.8	.	12.0	.
	4	mean	178.6	60.5	.	39.6	.
		%	64.1	21.7	.	14.2	.
	5	mean	311.1	259.5	.	390.3	.
		%	32.4	27.0	.	40.6	.
ESSF-wc2	1	mean	375.1	73.3	81.4	8.4	.
		%	69.7	13.6	15.1	1.6	.
	4	mean	293.4	328.7	94.7	42.0	.
		%	38.7	43.3	12.5	5.5	.
	5	mean	241.8	320.8	.	22.5	.
		%	41.3	54.8	.	3.8	.
ESSF-wc4	1	mean	181.7	207.3	92.0	86.0	.
		%	32.1	36.6	16.2	15.2	.
	2	mean	599.2	709.5	.	6.8	.
		%	45.6	53.9	.	0.5	.
	3	mean	544.2	483.3	14.9	114.3	.
		%	47.1	41.8	1.3	9.9	.
	4	mean	562.4	353.7	8.4	25.1	.
		%	59.2	37.2	0.9	2.6	.
	5	mean	67.4	239.0	21.6	.	.
		%	20.6	72.9	6.6	.	.
	7	mean	250.2	212.7	1.2	99.6	.
		%	44.4	37.7	0.2	17.7	.
	8	mean	321.2	293.8	.	.	.
		%	52.2	47.8	.	.	.
ESSF-wcp	0	mean	112.1	104.4	.	.	.
		%	51.8	48.2	.	.	.
ESSF-ww	1	mean	462.1	353.0	36.0	108.3	.
		%	48.2	36.8	3.8	11.3	.
	2	mean	397.9	321.2	.	187.4	.
		%	43.9	35.4	.	20.7	.
	3	mean	113.5	187.6	.	.	.
		%	37.7	62.3	.	.	.
	4	mean	551.3	226.6	159.7	133.4	.
		%	51.5	21.2	14.9	12.5	.

Appendix 3 (continued)

Tree class frequency by variant and site series
13:38 Monday, May 15, 1995

Variant	Site series		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha	Veteran stems/ha
ICHdu	1A	mean	370.6	435.4	.	45.4	.
		%	43.5	51.1	.	5.3	.
	1B	mean	568.1	204.9	6.8	420.1	.
		%	47.3	17.1	0.6	35.0	.
	3	mean	755.1	132.6	.	5.6	.
		%	84.5	14.8	.	0.6	.
ICHmk1	1	mean	346.3	514.0	48.6	.	.
		%	38.1	56.6	5.3	.	.
	3	mean	288.2	289.8	175.4	.	.
		%	38.3	38.5	23.3	.	.
	4	mean	470.9	611.0	84.9	6.4	2.7
		%	40.0	52.0	7.2	0.5	0.2
	5	mean	251.7	240.2	73.3	5.8	.
		%	44.1	42.1	12.8	1.0	.
	6	mean	431.8	304.8	47.4	9.6	.
		%	54.4	38.4	6.0	1.2	.
ICHmw1	1	mean	168.6	369.4	5.6	.	.
		%	31.0	68.0	1.0	.	.
	5	mean	615.3	128.2	.	.	.
		%	82.8	17.2	.	.	.
	6	mean	276.2	373.9	.	10.9	.
		%	41.8	56.6	.	1.7	.
ICHmw2	1	mean	261.7	227.8	2.7	36.1	0.8
		%	49.5	43.0	0.5	6.8	0.2
	3	mean	200.8	181.0	48.6	.	.
		%	46.7	42.0	11.3	.	.
	4	mean	315.8	360.7	37.2	35.2	.
		%	42.2	48.2	5.0	4.7	.
	5	mean	183.7	190.4	8.5	12.7	.
		%	46.5	48.2	2.1	3.2	.
	6	mean	429.8	173.8	.	88.2	4.7
		%	61.7	25.0	.	12.7	0.7
ICHvk1	1	mean	118.6	276.7	7.6	5.7	.
		%	29.0	67.7	1.9	1.4	.
	3	mean	313.4	400.9	19.0	40.6	.
		%	40.5	51.8	2.5	5.2	.
	4	mean	184.3	433.7	2.0	11.8	.
		%	29.2	68.6	0.3	1.9	.

Appendix 3 (continued)

Tree class frequency by variant and site series
13:38 Monday, May 15, 1995

Variant	Site series		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha	Veteran stems/ha
ICHvk1	5	mean	42.5	173.6	.	.	.
		%	19.7	80.3	.	.	.
	6	mean	112.6	335.2	30.7	34.3	.
		%	22.0	65.4	6.0	6.7	.
ICHwk1	1	mean	190.7	337.5	21.7	111.4	.
		%	28.8	51.0	3.3	16.8	.
	4	mean	164.5	500.7	21.4	48.3	0.2
		%	22.4	68.1	2.9	6.6	0.0
	5	mean	154.9	140.2	7.9	8.7	.
		%	49.7	45.0	2.5	2.8	.
	6	mean	200.4	160.8	.	.	.
		%	55.5	44.5	.	.	.
	8	mean	211.3	192.9	.	.	.
		%	52.3	47.7	.	.	.
IDFdm1	1	mean	613.0	442.6	33.9	85.0	7.5
		%	51.9	37.4	2.9	7.2	0.6
	3	mean	51.0	260.3	.	36.0	11.7
		%	14.2	72.5	.	10.0	3.2
	4	mean	330.0	220.3	1.9	124.0	.
		%	48.8	32.6	0.3	18.3	.
	5	mean	528.6	167.2	.	240.3	.
		%	56.5	17.9	.	25.7	.
	6	mean	20.7	95.8	.	33.0	.
		%	13.8	64.1	.	22.1	.
IDFdm2	1	mean	313.2	211.1	.	23.9	.
		%	57.1	38.5	.	4.4	.
	3	mean	.	249.4	.	125.2	.
		%	.	66.6	.	33.4	.
IDFun	0	mean	6.3	52.0	.	.	.
		%	10.8	89.2	.	.	.
MSdk	1	mean	475.1	518.6	43.1	184.7	1.6
		%	38.8	42.4	3.5	15.1	0.1
	3	mean	310.0	378.9	12.0	121.3	0.9
		%	37.7	46.0	1.5	14.7	0.1
	4	mean	466.7	302.7	.	42.5	.
		%	57.5	37.3	.	5.2	.
	5	mean	143.6	213.7	5.6	80.4	11.4
		%	31.6	47.0	1.2	17.7	2.5

Appendix 3 (concluded.)

Tree class frequency by variant and site series
13:38 Monday, May 15, 1995

Variant	Site series		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha	Veteran stems/ha
MSdk	6	mean	632.9	331.5	7.6	74.2	.
		%	60.5	31.7	0.7	7.1	.
MSdm1	1	mean	428.9	307.6	25.2	2.1	.
		%	56.2	40.3	3.3	0.3	.
	2	mean	179.8	382.6	227.3	.	.
		%	22.8	48.4	28.8	.	.
	4	mean	275.2	508.1	209.2	66.4	.
		%	26.0	48.0	19.8	6.3	.
	5	mean	745.9	522.0	151.6	304.9	.
		%	43.3	30.3	8.8	17.7	.
	6	mean	497.9	367.3	.	76.6	.
		%	52.9	39.0	.	8.1	.
	7	mean	567.6	464.0	65.2	16.3	.
		%	51.0	41.7	5.9	1.5	.
	8	mean	372.9	477.5	41.7	66.3	.
		%	38.9	49.8	4.4	6.9	.

The following are the transcribed field notes collected during reconnaissance or subsequent detailed sampling of old-growth stands. The notes have had minor editorial revision. Section I describes stands that had detailed sampling. Section II describes stands that were evaluated but not sampled in detail.

I. Stands Sampled

Almond Creek 20

Poly 372 is a CwHw old-growth stand in which large Lw & Fd stems were removed in old logging while leaving most of the rest of the stand intact. Poly 564 was much more disturbed with a higher proportion of younger stems on the numerous skid roads. Plots were established in Poly 372.

Cw 30 m	Hw 28 m	Cw 26 m	Hw 29 m
57.8 cm	26.0 cm	44.3 cm	50.9 cm
250 yrs	203 yrs	242 yrs	143 yrs

Angus Creek

The lower, eastern slopes of this deferral had stands with dominant and codominant whitebark pine, Engelmann spruce, and lesser amounts of subalpine fir. Many old, large-diameter trees of the first two species occur thoughout the area. Many openings generated by windthrow and tree mortality are present. Snags and living trees with broken tops are common. Intermediate tree and tall shrub layers are dominated by subalpine fir. The main understory plants included black huckleberry, white-flowered rhododendron, and false azalea. The site series are both ESSFwm/02 Bl Rhododendron - Azalea and ESSFwm/01 Bl Azalea - Arnica. A few whitebark pine veterans had dbh's of 43 to 47 cm. The main canopy trees had a range of diameters (22-55 cm). Subdominant dbh's had a range from 3 to 18 cm. Overstory tree ages were 235 to 410 years. Significant windthrow and other woody debris was estimated to cover 10% of the surface. Viewed from the west side of Angus Creek, whitebark pine is a major component over an extensive area (few hundred hectares?). This area was subsequently viewed by helicopter to assess parts of the stand not easily accessed by ground. Old-growth appears to extend from old harvesting near valley bottem to height of land. The stand has Engelmann spruce, subalpine fir, and whitebark pine. Whitebark pine occurs extensively in the stand and alpine larch is present near the ridge crests. In addition to large trees, large snags and large down logs occur extensively on the site.

Baker Creek

One sample point, approximately 1 km west of the confluence with Redding Creek, was examined during the reconnaissance survey. The site has a stand of western hemlock and western redcedar. Regeneration is mostly western hemlock with minor western redcedar. This "classic" old-growth CwHw in a wet area has an estimated 50–100 large snags/ha

and 1–10 large down logs/ha. One down log was 94 cm basal diameter and 22 m long. Stand age for trees with solid centrs was >170 years, while larger trees were probably much older but rotten cores prevents a true assessment of age. Understory plant species include: Vaccinium membranaceum, Oplopanax horridus, Gymnocarpium dryopteris, Tiarella uniflora, Clintonia uniflora, Athyrium felix-femina, and Orthilia secunda. Sample trees for reconnaissance: Hw, 72.5 cm dbh, 185 years old with estimated 27 cm of rot to reach centre; Cw 84.7 cm dbh, 78 years old in outer 4.5 cm with remainder of bole rotten; Cw, 78.7 cm dbh, age not determined due to rot.

Burrell Creek 18

This is an open, fire-induced, multi-aged stand of Fd9(PyLw) on a steep, rocky slope. The subzone seems to be ICHdw2 instead of ICHmk1 as mapped due to the Py and oceanspray. Although the trees sampled were old growth, most of the trees contained in the plots were not.

Fd 24 m	Py 31 m	Fd 31 m	Fd 25 m
55.0 cm	79.7 cm	61.4 cm	39.9 cm
155 yrs	202 yrs	209 yrs	125 yrs

Burton Creek - Southwest

This steep, rocky area on a warm aspect has a relatively open stand of Douglas-fir, ponderosa pine, and minor trembling aspen. Large ponderosa pine up to 1 m dbh occur at approximately 1–10 stems/ha. Very xeric to xeric site with Juniperus communis, Juniperus scoparium, Symphoricarpus albus, Acer glabrum, and Rosa sp. Trees sampled: i. Py, 110.4 cm dbh, 119 years on intact tissue with estimated 33 cm of rot to core, tree likely 200+ years old; ii. Fd, 54.6 cm dbh, 94 years on intact tissue with estimated 23 cm of rot to core, tree likely 150+ years old. This area was selected for detailed sampling.

Cartwright Lake 30

Most of this site was not old growth, but one plot was established in a grove of old-growth Fd. The area not considered old growth is described in Appendix 5 and the second part of this appendix.

Dogtooth 2

Several types in this area were looked at. Poly 15 at the south is old growth of Sx4Hw3BlFd with a large, well-used, ungulate corridor trail.

Hw 29 m	Sx 31 m
53.7 cm	67.8 cm
284 yrs	230 yrs

Poly 8 did not turn out to be old growth but is age class 7.

Sx 29 m	Fd 30 m
46.8 cm	40.7 cm
132 yrs	137 yrs

Polys 5, 2 & 6 are located above old logging and have areas of blowdown but are otherwise undisturbed.

Edgewood 34

This is a large CwHw + FdLwPw vets stand located on the boundary of Arrow and Boundary Districts. The stand is undisturbed by logging but has many broken tops.

Granby 32

Although most of this area was very highly disturbed by old logging, two plots were established in an isolated finger (Poly 564) of undisturbed old growth of SxCwHwBlPw + FdLw vets.

Hahas Lake

EKT - IDF dm2 - 82G 071. This area consists of a multi-aged stand of FdPy on a rocky, benchy ridge with a generally warm aspect. The numerous old snags and warm aspects make this a very high bird-activity area. Plots were established in this area.

Kokanee Creek

Ecoreserve for large Py. 50-200 trees/ha >50 cm dbh. Stand of large Py and Fd, large trees occur over entire area, stand >200 years old, some gaps in canopy. Lots of windthrown and windbroken Fd. Py has burn scars, insect and woodpecker activity including cavities, burrows for small mammals present. Regeneration is Fd with no Py found. Main understory plant species are Paxistima myrsinites, Rosa gymnocarpa, Linnaea borealis, and Chimaphila umbellata. Trees sampled at two locations: i. Py, 83.3 cm dbh, 220+ years; ii. Fd, 32.7 cm dbh, 100 years old; iii. Py, 49.6 cm dbh, 178+ years old; iv. Fd, 68.6 cm dbh, 198+ years old.

Lewis Creek

This is a large, open ponderosa pine–grassland stand that has been underburnt in the last five years. It is a good example of this stand type, it is rare in the rest of the Rocky Mountain Trench because of human disturbance. The area was walked and limited observations were made. Native grasses and herbs were in good range condition. In particular, rough fescue was quite plentiful.

Lodgepole Creek

BRR - ICHmk1 - 82G 027. This stand is located on a rocky ridge at the upper limits of the ICHmk1 with a site series 04. The stand is PlPaFdLw(SxBl) with much of the older Pl affected by bark beetle mortality and blowdown resulting in high, coarse, woody debris.

Midway 35

Although this stand is old growth, the large-diameter stems were removed by old logging. This remains one of the few stands of IDFdm1 old growth in the Southern Okanagan Highlands within the Nelson Forest Region. It contains some pockets of stagnant Pl&Fd.

Fd 25 m	Fd 24 m	Lw 27 m	Fd 29 m
44.1 cm	37.1 cm	28.3 cm	40.7 cm
158 yrs	145 yrs	162 yrs	133 yrs

Parsons 1

This type is located on a fluvial fan adjacent to the Columbia River north of Parsons. There has been some old logging, but much of the stand is still old growth with a mix of Cw4Sx4(BlEpFd)+Fd vets.

Cw 27 m	Sx 29 m	Cw 24 m	Sx 26 m
56.3 cm	39.8 cm	47.8 cm	45.5 cm
180+ yrs	103yrs	250+ yrs	148 yrs

Perry Creek - North

A ground transect with observations was completed on the north side of Perry Creek. A significant part of the north side of Perry Creek includes an open stand of ponderosa pine and Douglas-fir with an understory of bluebunch wheatgrass, snowberry, and balsamroot. The trees sampled ranged in age from 80 to 207 years (tops of the ponderosa pine were often very broad and forked suggesting ages older than those sampled). This type of species composition and stand structure is unique at this elevation (1150 m) in the eastern Purcells. This stand is a fire-climax in the Kootenay Dry Mild Interior Douglas-fir variant. There is moderate ungulate use and very high squirrel activity. The largest cause of mortality seems to be tumbling rocks, mostly from road grading on the Perry Creek FS road, which are damaging the old-growth stand and causing infection. Other, denser portions of the stand were not sampled because of limited time.

Perry Creek - South

A ground transect with two detailed sample plots was completed on mid-to-lower slopes, south side of Perry Creek (map notation 1759, mapsheet 82G12W). This side of Perry

Creek deferral area is in the dry, cool subzone of the Montane Spruce Zone (MSdk). This area consists of two main strata.

The first strata (1) is an open stand with western larch and Douglas-fir as dominants and codominants. Douglas-fir and lodgepole pine are found in the intermediate and tall shrub layers. Douglas-fir is the only tree species regenerating. Western larch is conspicuously absent as regeneration. Pinegrass and feathermoss pussytoes are the main understory species. Arboreal lichens (*Bryoria* spp. *Letharia vulpina*) are common. The area is a complex of bedrock outcrops and soil veneers of varying depth. Both the 02 Saskatoon–Bluebunch Wheatgrass and 03 Pl Juniper–Pinegrass site series are found. The overstory trees sampled are 227 to 297 years old and diameter at breast height ranges from 22 to 55 cm. Subdominant trees are younger and diameters range from 3 to 22 cm. Snag density is 200/ha with largest in the 25–30 cm range. There are relatively low volumes of coarse woody debris, although some recent windthrows were observed. Fire scars were common on the larger live trees and snags. Wildlife signs included woodpecker marks and a well-defined game trail. The stand appears not to have experienced fire for over 100 years judging by the presence of mature lodgepole pine without fire scars. In the absence of fire, Douglas-fir will predominate this strata due to the lack of any other regeneration. The second strata (2) is encountered in the western portion of the block as the soil deepens, the aspect becomes more northerly, and the drainage narrows. The predominant site series is MSdk/01 Sxw Soopolallie—Grouseberry. Canopy dominants are western larch and minor Douglas-fir. The intermediate and tall shrub layers are denser than in the previous strata and are comprised of Douglas-fir, lodgepole pine, western red cedar, and hybrid spruce. Again, western larch was conspicuously absent below the main canopy. The main understory plants were false azalea, birch-leaved spirea, twin flower, and red-stemmed feathermoss. The overstory western larch were approximately 300 years old and diameter at breast height was 47–52 cm. Understory trees were younger, had a range of ages, and a range of sizes (1–24 cm). Snag density was 100/ha with largest dbh of 24 cm. This stand had four times the volume of coarse woody debris as the first stand (154 m^3/ha). Fire scars were common on western larch, windthrow without root rot was observed, and a few pine beetle exit holes were observed. This strata also appears to be a fire-maintained stand where fire exclusion is limiting western larch and Douglas-fir regeneration and allowing western red cedar and hybrid spruce germinants to survive.

Premier Ridge 29

Plots were established in this old-growth stand on top of Premier Ridge adjacent to recent logging on the south end and abutting Premier Lake Provincial Park. The large stand of old-growth Fd with pockets of dense Fd regen, the steep terrain (100%), and the high visibility from Premier Lake make this a good candidate for retention.

Quinn Creek - North

This is a high-elevation stand on a steep rocky slope that is dissected by avalanche slopes. Trees include subalpine fir, Engelmann spruce, and a significant component of Fd.

Understory plant species include Ribes lacustre, Shepherdia canadensis, Spirea betulifolia, Lonicera utahensis, Vaccinium membranaceum, Vaccinium scoparium, Actaea rubra, Arnica cordifolia, and Thalictrum occidentale. Bear scat and game trails present on the site. Reconnaissance trees sampled: i. Bl, 33.2 cm dbh, 200+ years old; ii. Fd, 67 cm dbh, 293 years old; iii. Se, 88.2 cm dbh, 110 years old. Subsequent helicopter viewing found that old growth extends from earlier harvesting at base of cliffs to tree line, a significant component of Douglas-fir occurs on the lower slopes, and the stand appears to grade from MSdk to ESSFdk at higher elevations.

Quinn Creek - South

Observations were collected at four locations on the reconnaissance. The site overlooks Quinn Creek and is surrounded by areas with significant disturbance due to fire and timber harvesting. The site has a stand of hybrid spruce, subalpine fir, and Douglas-fir overstory with hybrid spruce and subalpine fir regeneration. This site is transitional between two subzones, has more Douglas-fir on warm aspects, and has pockets of lodgepole pine mortality and blowdown. The site has lots of large snags and down logs (Fd snag, 80.8 cm dbh). Understory plant species include Vaccinium membanaceum, Vaccinium scoparium, Acer glabrum, Lonicera utahensis, Rubus parviflorus, Juniperus communis, Sheperdia canadensis, Spirea betulifolia, and Disporium hookeri. Woodpecker cavities and game trails are common. Trees sampled: Fd, 63.5 cm dbh, 235 years old; Fd, 42.0 cm dbh, >225 years old; Fd, 61.1 cm dbh, 325 years old;

Redding Creek

During the reconnaissance examination, one sample point was examined. This site is on the Redding Creek floodplain and is just east of the confluence with Baker Creek. The stand has hybrid spruce and western redcedar with minor western hemlock and subalpine fir. Regeneration is present for the first two species. Stand age could not be properly assessed as the larger trees had rotten centrs, although smaller trees were 180 years old. Snags and large down logs, comparable in size to the larger standing trees, were present. Understory plant species include Oplopanax horridus, Vaccinium membraceum, Athyrium filix-femina, Dryopteris expansa, Tiarella trifoliata, Rubus pedatus, Clintonia uniflora, and Pleurozium scherberi. Trees sampled: Cw, 201.0 cm dbh, no age as rotten; Cw, 103.7 cm dbh, no age; Sxw, 59.2 cm dbh, 184 years old.

Rendell Creek - Mouth

These stands are part of Pope & Talbot's proposed 5-year plan. The south block is located on steep rock outcrops with more gentle slopes towards the west. The mid block is a benchy FdLw(Pl)+Lw vets stand with many large (>100 cm dbh) Lw vets along the creek. The north block has more scattered FdLw vets and is mostly FdPl. There are scattered, large-diameter Lw vets within the connecting stands of Pl.

Rendell Creek 17

This is a rare stand of large (>100 cm dbh) Fd and Pw over 300 years old with 200+ year-old SxCwBlHw slowly taking over. The area is as yet undisturbed, but Pope and Talbot has built a road and landing into the base of the stand.

Sanca Creek

First sample point is xeric site with Fd, Py stand. Understory plants include Philadelphus lewisii, Shepherdia canadensis, Mahonia aquifolium, Arctostaphylos uva-ursi, and Calamagrostis rubescens. Py, 67.7 cm dbh, 306 years old. Second sample point is >50% bedrock at surface. Fourth sample point is rubbly colluvial blanket/veneer overlying steep rock. Stand is in area with >50% rock and talus slopes. Game trails, but limited use for deer/elk on much of the area because of rock and steep slopes. Noticed skunk smell, deer pellets, ants. Very low-density Py and Fd stand, few large class 4-5 snags nearby, 7 cm dbh Prunus emarginata in sample plot. Just outside the plot sampled one tree: Py, 81.3 cm dbh, 200+ years old.

Skookumchuck 2

This site has two stand types. The east end near the highway is Fd7Py3 with a Py vet overstory and a Fd (10-12m) understory.

Py 20.2 m	Py 23.4 m
43.2 cm dbh	37.9 cm
151 yrs	132 yrs

The west side is Py8Fd2, and is an open stand. There is high ungulate use and a fenceline straddles the stand.

Wigwam River

Reconnaissance near south end of stand. Part of floodplain and associated fluvial terraces on east bank of Wigwam River. Stand has large hybrid spruce, Douglas-fir, western redcedar, and black cottonwood. Many snags and large down logs of various decay classes. Understory and regeneration includes western hemlock and hybrid spruce. Understory species include Menziesii ferruginea, Vaccinium membranaceum, Aralia nudicalus, Clintonia uniflora, Viola canadensis, Tiarella unifoliata. Elk pellets. Trees sampled: i. Fd, 87.0 cm dbh, 213 years old; ii. Sxw, 57.1 cm dbh, 155 years old. This area was not sampled but was noted on maps. Above floodplain on east side of Wigwam River stand consists of Douglas-fir, subalpine fir, hybrid spruce, and few western larch. Few large snags, down logs or other attributes of old growth. Subalpine fir trees had rotten core and age not determined. Trees sampled: i. Fd, 35.6 cm dbh, 82 years old; ii. Fd, 31.8 cm dbh, 77 years old. This part of stand rejected as old growth. West side of Wigwam River had stand of Douglas-fir with minor paper birch on fluvial terraces near river and on

steeper, rocky, drier slopes above. This multi-aged stand is predominantly Fd with many gaps due to disease, shallow rooting, and windthrow, resulting in high, coarse woody debris and wildlife trees. This area had many large-diameter trees and snags (>50 cm). The snags included several decay classes. Understory plant species included Acer glabrum, Symphoricarpus albus, Shepherdia canadensis, Amelanchia alnifolia, Spirea betulifolia, Juniperus scoparium, Aralia nudicalus, and Calamagrostis rubescens. Trees sampled on reconnaissance of area: i. Fd, 49.8 cm dbh, 184 years old; ii. Fd, 72.9 cm, 248 years old. This dry area above the river was selected for detailed sampling. On the west side, moister slopes plus areas adjacent to the river were estimated to be ICHmk1–05 site series. This site series occurred less extensively than the drier site series, a reconnaissance was completed, and detailed sampling was not done. Areas with this site series had stands of Douglas-fir, hybrid spruce, western redcedar, and western larch. Ponderosa and western white pine form a minor component of these stands. These stands were estimated to be >200 years old and all tree species had a range of sizes up to and including 1 metre dbh. Many of the snags had signs of significant past and current use by cavity nesters. Deer, elk, and moose pellets were abundant and many game trails were present. Trees sampled on reconnaissance: i. Py, 81.4 cm dbh, 187 years old to rot with estimated 18 cm of rot to core; ii. Lw, 76.9 cm dbh, 145 years old to rot with estimated 18 cm of rot to core. Subsequent helicopter viewing confirmed the presence of high densities of trees, snags, and down logs of large dimensions. The old growth extends over most of the west bank of the Wigwam River and to the height of land. Tree species composition is Douglas-fir, hybrid white spruce, western larch, and western redcedar at low elevation. Subalpine fir and Engelmann spruce occur at higher elevations. Subzone/variants are probably ICHmk1 at low elevation and ESSFdk at higher elevation.

II. Stands Examined But Not Sampled

Baker Creek - West

CCM - ESSFwm - 82F067. This mixed-age BlSx stand has large pockets of Bl mortality with BlSx regen. It has a cool aspect with colluvial material and high, coarse woody debris up to 80cm.

Site series 01	Elev 1580	Aspect 003	Slope 50%
Sx 168 yr	dbh 67.3 cm	ht 42.8 m	
Bl 83 yr	dbh 35.9 cm	ht 31.3 m	

Baribeau Creek

Forest Cover Map: 82F068, Ecosection: CCM. This area was only viewed by helicopter, during September 1993. The upper part of this drainage has stands of large, subalpine fir and Engelmann spruce. Large snags and down logs occur extensively in this area. The subzone map designation for this drainage is ESSFwm in the upper reaches with ICHmw2 near the confluence with Redding Creek. Based on aerial viewing and earlier ground-truthing near Redding Creek, this classification appears correct. Ground-truthing would

be required to determine site series and extent of the biogeoclimatic units. The stand is a good example of old-growth in the ESSFwm. As noted above, older age classes are not considered rare in this subzone.

Bartlett Creek

East of Silverton and New Denver. Overstory of Douglas-fir, western redcedar, western hemlock, western white pine, trembling aspen, and paper birch. Regeneration includes western hemlock, western white pine, and western redcedar. Understory species include Shepherdia canadensis, Rosa gymnocarpa, Mahonia aquifolium, Chimaphilla umbellata, Clintonia uniflora, Orthilia secunda, and Steptopus amplexifolia. Two sample trees: i. Fd, 50.4 cm dbh, 112 years old; ii. Fd 44.8 cm dbh, 95 years old.

Brides Creek 36

This Lw7Fd3 stand is located within a woodlot licence, presently has cattle grazing and high ungulate use, and has been selectively logged in the past. The type is located within the MSdm1 due to elevation and exposure and not IDFdm1 as mapped. Although there are big trees, they are too young for old growth.

Fd 30 m ht	Lw 31 m
44.7 cm dbh	36.0 cm
127 yrs	133 yrs

Fd 25 m	Fd 24 m
53.5 cm	37.2 cm
73 yrs	73 yrs

Bugaboo 31

This stand is on the north side of Bugaboo Creek and consists of Fd6Pl3Sx1(Bl)+ Fd vets. The stand was too young and not sampled for old growth.

Fd 31 m ht	Pl 29 m	Fd 26 m
47.0 cm dbh	37.4 cm	43.5 cm
116 yrs	113 yrs	78 yrs

Burton Creek - North and East

The unit was broken into two areas for reconnaissance purposes, due to access. The northern area was viewed by helicopter on Sept. 22, 1993. The lower elevations of the northern area has Douglas-fir, western larch, hybrid spruce, and western redcedar (probable subzone is MSdk). Upper slopes have subalpine fir and Engelmann spruce grading into alpine parkland on the mountain top (probable subzone is ESSFwm or dk). This area looks like mature timber with some large trees, a low density of snags, and

relatively low quantities of large down logs. Not considered further for sampling. A second area to the southeast was examined by ground traverse. Much of the area has had disturbance by clearcut logging, and some intact stands are only 100 years old. It was mislabelled as IDFdm2. It should be MSdk below 1600 m and ESSFwm above this elevation. Data collected from intact forest. Englemann spruce and subalpine fir stand with Lonicera utahensis, Rubus parviflorus, Thalictrium occidentalis, Amelanchier alnifolia. A few Pinus albicaulis snags were present. Trees sampled: i. Se, 37.6 cm dbh, 90 years old; ii. Bl, 31.0 cm dbh, 148 years old; iii. Se, 47.0 cm dbh, 117 years old; Se, 58.8 cm dbh, 142 years old. Not considered further for sampling because of logging and not a subzone of interest for rarity.

Cartwright Lake 30

This stand of Fd5 Pl4 (BlSx)+Fd vets is adjacent to a F.S. rec. site. The Fd vets vary in density from 2–3/ha in the south end to 10–15/ha in the north end of the stand. The Pl component is dying out and blowing over. The northerly polygon was previously logged and overall was too young.

Fd 26 m ht	Pl 24 m	
44.8 cm dbh	32.0 cm	
128 yrs	116 yrs	
Fd 28 m	Pl 23 m	Fd vet 31 m
44.7 cm	29.8 cm	84.0 cm
127 yrs	126 yrs	260 yrs
Fd 27 m	Fd 22 m	Pl 22 m
58.7 cm	30.9 cm	25.5 cm
138 yrs	148 yrs	116 yrs

Dogtooth 1

The northeastern section of this stand has recently been selectively logged for Pl while retaining the Fd component, which was too young.

Fd 24 m ht	Fd 24 m
36.7 cm dbh	38.5 cm
94 yrs	92 yrs

The main portion of the stand is a mix of Pl4 Fd4 Sx(CwBl) and was also found to be too young.

Fd 29 m ht	Pl 26 m	Fd 30 m
56.8 cm dbh	30.8 cm	67.2 cm
93 yrs	103 yrs	92 yrs

Granby River 22

The north-facing side of this type is a CwHw stand that was heavily logged in the past with many thickly regenerated skid roads. There are patches of old growth but too disturbed for consideration.

Hw 24 m	ht	Cw 28 m
38.2 cm	dbh	37.7 cm
177 yrs		180+ yrs

The south-facing side is also highly disturbed and shrubby with scattered old growth.

Se 29 m	ht	Fd 27 m
44.6 cm	dbh	45.5 cm
149 yrs		122 yrs

Granby River 32

Most of this area is CwHwSx that has been highly disturbed by old logging with many brushy skid roads remaining. Poly 329 has a mix of CHBSFLPwPl with some scattered old-growth stems, but generally too disturbed.

Fd 28 m	ht	Pw 27 m
42.1 cm	dbh	44.5 cm
187 yrs		145 yrs

Grohman Narrows

Overlooking Grohman Narrows, west of Grohman Creek. Open-grown stand of ponderosa pine and Douglas-fir. Area disturbed with much of area covered by weedy composites. Shallow to bedrock soils. Although large trees, oldest is approximately 100 years, these are just rapid and open-grown trees. Site appears to be ingrowth on former grassy area, due to fire suppression. Trees sampled at five locations selected at random distances along the slope: i. Py, 63.5 cm dbh, 105 years old; ii. Fd, 60.5 cm dbh, 60 years old; iii. Py, 78.1 cm dbh, 102 years old; iv. Py, 67.8 cm dbh, 69 years old; v. Fd, 60.8 cm dbh, 75 years old; vi. Py, 55.7 cm dbh, 54 years old; vii. Py, 63.8 cm dbh, 93 years old; viii. Fd, 66.0 cm dbh, 65 years old; ix. Py 58.5 cm dbh, 62 years old.

Hahas Lake - West

A reconnaissance transect was undertaken with limited data collection. It is IDFdm2 site series 03 with a mixed-aged stand of predominantly FdPy with pockets of old growth and large sections of 30-40 year old Fd. The area is rocky and benchy with high ungulate and bear use. There have been previous patchy burns and logging that have resulted in much large-diameter, class 4, coarse woody debris. The following data was collected:

Elev 1060	Aspect 110	Slope 60%
Fd 238 yrs	dbh 71.2 cm	
Py 178 yrs	dbh 56.5 cm	

While this area does not in itself qualify for an old growth reserve, it could be considered as an addition to the Hahas Lake area.

Jubilee Mountain 43

The northeastern portion of this stand is in the ESSFdk and is a fire-and old logging-induced mosaic of small patches of old growth and young (30-50 yr) thick Fd.

Fd 22 m	ht	Fd 22 m
55.5 cm	dbh	61.7 cm
207 yrs		177 yrs

Poly 212 is in the MSdk with patchy fire history and a recent clearcut in the centre. The remainder is Fd9Pl and generally was too young for old growth.

Fd 28 m	ht	Fd 29 m	Fd 32 m
37.4 cm	dbh	48.5 cm	62.0 cm
104 yrs		107 yrs	89 yrs

Midway 26

This IDFxh1 type is located on private land and was not visited.

Midway 45

This PPdh1 type is located on private land and was not visited.

Miller Road

Stand is primarily open stand of Douglas-fir. Ponderosa pine occurs at low density. Regeneration for both species is present. A few western larch and lodgepole pine were observed. The larger trees range in size from 40 cm to 50 cm dbh. Understory plant species include Shepherdia canadensis, Spirea betulifolia, Amelanchier alnifolia, Symphoricarpus albus, Artostaphyllus uva-ursi, Agropyron spicatum, Calamagrostis rubescens, Stipa comata, and Achillea millefolium. Some past single-tree selection has occurred and the area has recent grazing. Prior to fire suppression, this area would have been a more open stand of large ponderosa pine with less Douglas-fir, western larch, and lodgepole pine. This stand was not sampled because of the grazing, extensive ingrowth of Douglas-fir, and the disturbed nature of the site. It could be considered for old-growth

management if grazing were stopped/reduced and low-intensity underburning were used to create a more open stand with fewer but larger ponderosa pine and Douglas-fir.

Moyie Floodplain

MCR - IDFdm2. This stand is located on fluvial deposits and consists of FdAcLw with occasional Fd vets. One sample was taken:

Site Series 03 Elev 980 Aspect 120 Slope 2%
Fd 170 yrs dbh 69.7 cm
Fd 165 yrs dbh 94.6 cm

Moyie North

MCR - IDFdm2. This is a very steep open stand bounded on one side by a logged area and on the other by cliffs above the Moyie floodplain. The area is small, growing on rock and colluvium and in little danger of being logged due to the steepness. The sample results follow:

1. Site Series 02 Elev 1120 Aspect 230 Slope 130%
Fd 187 yrs dbh 49.4 cm ht 25.4 m
Py 164 yrs dbh 63.8 cm ht 26.8 m

2. Site Series 01 Elev 1090 Aspect 215 Slope 60%
Fd 248 yrs dbh 78.4 cm
Py 186+ yrs dbh 71.0 cm

While this area would barely qualify as an old growth area due to its small size and scattered trees, it may be a good candidate to be included with an adjacent area.

Moyie South

SCM - ICHmk1. This is a cool aspect, mixed-age stand of FdLw(PlCwSxBl). The stand is variable due to the numerous colluvial slides. There is a consistent but scattered old-growth component throughout. The old (120+) Pl is dying out and creating heavy blowdown. The regen is mainly Fd(Cw) and there are numerous ungulate trails connecting the openings. Two samples were taken as follows:

Site Series 03 Elev 1110 Aspect 45 Slope 65%
Fd 143 yrs dbh 57.4 cm
Lw 184 yrs dbh 59.0 cm

Site Series 03 Elev 1135m Aspect 37 Slope 85%
Fd 164 yrs dbh 51.9 cm
Fd 176 yrs dbh 57.2 cm

This area would qualify as a potential old growth site and should be further sampled.

No Name Creek

Forest Cover Map: 82G009, Ecosection: COC. During September 1993, a brief aerial viewing by helicopter was combined with one ground sample point. This creek drains into Kishinena Creek from the north. The area is ESSFdk—site series 01. The area has a stand of large Engelmann spruce and subalpine fir. Regeneration for both species is present. Relatively large numbers of snags and down logs in various stages of decay are present. It is estimated that 30-50 snags/ha were present on the site. A 86 cm snag was measured, and living trees of similar size are present. Understory species include Vaccinium membranaceum, Menziesia ferruginea, Tiarella trifoliata var. uniflora, Rubus pedatus, and Xerophyllum tenax. The stand could be considered a "classic" example of old-growth in this subzone. However, the unit was indicated as MSdk in the consulting report. The regional biogeoclimatic map has this area labelled as ESSFdk. ESSFdk in this ecosection is not a unit with relatively rare older age classes (37%). Trees sampled at one helicopter stop: Se, 50.0 cm dbh, 283+ years old; Se, 56.7 cm dbh, 350+ years old; Bl, 34.2 cm dbh, 170 years old.

Parsons 3

This stand of Fd(SxCwEpAt) is located on the west side of the Columbia River NE of Parsons. It is a homogeneous stand with signs of old logging and burning and adjacent to a recent (1993-94) selection logging. The stand is too young for old growth.

Fd 24 m ht	Fd 26 m
34.5 cm dbh	49.8 cm
77 yrs	67 yrs

Rock Creek North 42

This an open Fd stand located on rocky outcrops with scattered old Fd vets. There is presently grazing, and there has been some old, high-grade logging. The remaining trees are mostly too young for old growth.

Fd 13 m ht	Fd 18 m	Fd 16 m
45.6 cm dbh	52.7 cm	42.8 cm
118 yrs	122 yrs	80 yrs

Rock Creek West 27

This Fd(Lw)+FdPy vets stand is located on rocky outcrops and surrounded by private land. There is presently grazing and it has been logged in the past. The present stand is too young.

Fd 26 m ht	Fd 28 m
37.4 cm dbh	40.9 cm
99 yrs	85 yrs

Skookumchuck 1

This site is located east of the Kootenay River about 2 km north of the Skookumchuck pulp mill. The stand can be broken down into three different strata. The southeast end is a Py(Fd) stand on a Fgt and generally <140 yrs old. There has been old logging, burning, and consistent grazing in the area. The following samples are some of the largest trees in the stand:

Py 14.1 m ht	Py 18.9 m ht
34.5 cm dbh	49.1 cm dbh
122 yrs	130 yrs

The middle section has a bench with a young PyFd stand (Py 43.2 cm, 112 yrs; Fd 46.8 cm, 117 yrs), a slope above the floodplain with large PyFd vets and a Fd understory:

Py 22.2 m ht	Fd 26.7 m ht
45.1 cm dbh	63.5 cm dbh
171 yrs	158 yrs

and a SxFd(Py vets) on the floodplain:

Sx 26 m (E)	Fd 23 m (E)
45.4 cm dbh	39.5 cm
131 yrs	95 yrs

The north end is Fd6Py4(PlLw) with rare Py+Fd vets scattered over the area. There is a fence line bisecting the stand.

Fd 19 m (E)	Py 18 m (E)
52.4 cm dbh	44.4 cm
117 yrs	122 yrs

This area was not sampled because of the overall young ages and the heterogeneous nature of the stand and terrain types. This site is connected to Site 2 by a thin band of very open, scattered Py on the bank above the Kootenay River.

Skookumchuck 3

This area is situated in the Lower Lussier canyon above Skookumchuck. The north side of the valley varies from PPdh2/ 02a-04 on a south-southwest exposure on a glaciofluvial

deposit varying from an open Py stand to Sx stands on riparian benches. Some of the samples are:

Fd 26.9 m ht	Py 29.4 m
48.8 cm dbh	56.7 cm
123 yrs	123 yrs
Sx 15.5 m	Py 32.0 m
41.5 cm dbh	56.3 cm
104 yrs	107 yrs
Fd 26.3 m ht	Py 27.7 m
54.5 cm dbh	52.2 cm
98 yrs	88 yrs

Although there were scattered Fd and Py vets throughout the stand, it did not meet old growth requirements.

The south side also was a young stand with pockets of Py, Fd & Lw vets especially, in the SW corner of the stand in the more open areas. Some of the northerly exposed areas seem to be transitional IDFdm2.

Fd (vet) 26.8 m ht	Sx 24.3 m
64.3 cm dbh	35.4 cm
242 yrs	98 yrs

Although this area does not meet the old-growth requirements, the high ungulate use, erosion concerns, complex nature of the stand, and relatively untouched nature make it a good candidate for retention on these values.

Skookumchuck 4

This site is located on a glaciofluvial terrace above the Kootenay River and adjacent to an F&W-owned property. The largest trees were sampled in a Py6Fd4 stand with few B layer trees.

Fd 25.9 m ht	Py 24.1 m
57.3 cm dbh	49.7 cm
123 yrs	117 yrs
Fd 21.5 m ht	Py 17.0 m
54.5 cm dbh	49.8 cm
103 yrs	124 yrs

The adjacent F&W property was also briefly examined. This area was spaced and underburned to retain the mainly Py overstory. Although some old-growth vets were found, the general age of the mature trees is 120-130 years.

Fd 22.5 m ht	Py 18.4 m
55.3 cm dbh	47.3 cm
130 yrs	130 yrs
Fd 20.0 m ht	Py 19.2 m
47.9 cm dbh	43.2 cm
163 yrs	139 yrs

The stand within the F&W property on the slope down to the Kootenay River floodplain was also briefly examined and found to be a young (class 4) stand of Fd7Py3 with some large Py & Fd vets scattered throughout.

None of these stands were able to meet old-growth criteria.

Skookumchuck 7

This is a small (20 ha) stand along Hwy #93/95 just south of Skookumchuck. It varied from very open Py to thick Fd with some old-growth vets scattered throughout; however, it was too young to be considered an old-growth area.

Py 16.1 m ht	Fd 20.6 m
33.3 cm dbh	48.8 cm
129 yrs	111 yrs
Py 16.5 m ht	Py 14.8 m
48.4 cm dbh	29.5 cm
113 yrs	68 yrs

Skookumchuck 9

This stand is located about 2 km up Wolf Cr. Road on the north side. The area has been disturbed by past logging, burning, grazing, and a recent spacing project that has removed much of the thick Fd understory in alternating fingers approx. 100 m wide. Although there are small pockets of old-growth vets, the stand was generally too young for old growth.

Fd 18.8 m ht	Py 12.6 m
41.5 cm dbh	26.4 cm
143 yrs	107 yrs
Fd 17.6 m ht	Fd 20.0 m
29.5 cm dbh	45.0 cm

76 yrs 103 yrs

Snowcrest Creek

Forest Cover Map: 82F058, ecosection: CCM. The area was only viewed by helicopter, with no ground truthing, during September 1993. This drainage flows north into Redding Creek. The stand has subalpine fir and Engelmann spruce. Trees, snags, and down logs of relatively large size occur extensively in this drainage. Forest cover polygon information indicates that western white pine, lodgepole pine, western hemlock, and western redcedar are also found in the drainage. The latter two species would likely occur at lower elevations. The drainage is labelled ESSFwm on the subzone map. This label appears to be correct, although ground verification is desirable. Assuming the subzone is correct, the drainage is a good example of old growth in this biogeoclimatic unit. However, this biogeoclimatic unit has 52% age classes 8 + 9 in this ecosection.

South Canal Flats

EKT - IDF dm2 - 83J002. Upon the suggestion of the Invermere District Planner, a landlocked piece of Crown forest south of Canal Flats between the Kootenay River and Hwy 93/95 was looked at. The area has been both logged and burnt in the past. The resulting stand is of mixed ages with an old-growth (>200 yr) overstory. There seems to be little coarse woody debris due to the fire history, and the large pieces remaining appear to be old logging slash. There is high wildlife use as indicated by the numerous ungulate trails. POLY 301 is F(L,Py,Pl) and is site series 01/03 on rocky ridges and gullies. Two samples were taken with the following results:

1) Elev. 970m	Aspect 190 deg	Slope 10%
Lw - 213 yrs	dbh 35.3 cm	ht 27.3 m
Fd - 148 yrs	dbh 56.6 cm	ht 28.0 m
Py - 90 yrs	dbh 57.7 cm	ht 28.6 m
2) Fd - 159 yrs	dbh 42.8 cm	ht 21.7 m
Py - 126 yrs	dbh 44.0 cm	ht 19.8 m
Lw - 135 yrs	dbh 43.9 cm	ht 25.6 m

POLY 302 is almost a pure Fd stand on morainal material sloping to the Kootenay River floodplain with a warm aspect.

3) Elev 920	Aspect 280	Slope 20%
Fd - 223 yrs	dbh 41.2 cm	ht 25.3 m
Fd - 226 yrs	dbh 50.4 cm	ht 24.5 m

POLY 328 is another mixed stand of Fd(Lw); its cool aspect has a much thicker B1/B2 layer of Fd.

4) Elev 1050	Aspect 360	Slope 20%
Fd - 268 yrs	dbh 59.4 cm	ht 24.9 m
Fd - 267 yrs	dbh 59.8 cm	ht 30.2 m

This area should be treated as one unit and is a good candidate for an old-growth reserve and further sampling.

Split Creek 19

This is a small patch of BlSx between a large stand of ESSFwc1 old growth in the Kamloops Forest Region and a huge (2000 ha) clearcut. The site is in the ESSFwc1 and not ICHmk1 as mapped; however, it is too young.

Sx 31 m ht	Bl 26 m
53.6 cm dbh	35.0 cm
116 yrs	100 yrs
Sx 27 m	Bl 28 m
39.4 cm	37.8 cm
103 yrs	115 yrs

Steamboat Mountain 1

This stand of Fd9Pl1 is located at the southeast end of Steamboat Mtn. It was found to fit into the MSdk subzone and was younger than old-growth criteria.

Fd 15.7 m ht	Fd 16.2 m
38.7 cm dbh	37.0 cm
133 yrs	132 yrs

Steamboat Mountain 3

This stand of Pl9(SxBl)+Fd vets also appears to fit into the MSdk subzone and is too young for old growth.

Pl 20.5 m ht
24.8 cm dbh
102 yrs

Steamboat Mountain 4

This stand of Fd8Pl2 +(Fd vets) was generally less than 140 yrs old and fit into the MSdk subzone. It is located on a steep SW-facing slope and has some Se and Bl in receiving areas.

Fd 19.3 m ht	Pl 21.2 m
39.9 cm dbh	46.7 cm
130 yrs	138 yrs

Fd 24.4 m ht	Pl 23.3 m
32.3 cm dbh	29.6 cm
112 yrs	123 yrs

Steamboat Mountain 5

This stand of Se8Pl(FdBl) is located on Steamboat Mtn. at the top of Bryanton Creek in a receiving area. Although it is too young to be considered old growth, it is one of the few mature stands of ESSFdk within the EKT. There appears to be a cutblock laid out in this stand.

Se 28.0 m ht	Se 25.0 m
44.2 cm dbh	27.2 cm
120 yrs	123 yrs

Se 24.5 m ht	Se 26.5 m
33.3 cm dbh	41.0 cm
126 yrs	125 yrs

Syringa Creek

South side of Ladybird Mountain. Open stand of ponderosa pine with grassy areas. No dead trees or large logs, most trees 60 cm dbh or smaller, and rare (1/ha or less) large ponderosa pine. Area looks like former open grassland with low-density ponderosa pine. Subsequent ingrowth due to fire suppression. Sampled average canopy tree: Py, 63.3 cm dbh, 87 years old. Also sampled largest (oldest?) tree in stand: Py, 93.5 cm dbh, 173 years old. Estimate that trees of this latter size only occur at rate of 1/10 ha to 1/100 ha. One small patch of trees on the western edge of the stand had the most large trees. It was considered too small to sample because of its size (20 ha) and extensive edge. Two trees sampled in this patch: i. Fd, 80.3 cm dbh, 98 years old; ii. Py, 82.7 cm dbh, 192 years old. The latter-sized tree was rare and occurred at rate of <1/10 ha. This patch appears to also be a forest ingrowth area created by fire suppression.

Ward Creek

This area was examined by helicopter during September 1993. Ward Creek, a proposed ecoreserve, has large western larch, hybrid white spruce, and Douglas-fir. The stand also has many large snags and down logs. It is a good example of old growth. Stand age and the subzone map designation of ICHmk1 - ICHmw2 need to be verified by a ground sample.

Yahk River

Reconnaissance transect with observations at five points. The stand consists of lodgepole pine, Engelmann spruce, subalpine fir, and, at lower elevations, minor western hemlock. Regeneration is primarily subalpine fir with less Engelmann spruce. The stand has few large snags and a few patches with many small down logs of lodgepole pine. Major mortality agent is mountain pine beetle. Best described as a mature seral stand of lodgepole pine. Understory plant species include Menziesia ferruginea, Rhododendron albiflorum, Vaccinium membranaceum, Vaccinium scoparium, and Arnica latifolia. Trees sampled: i. Pl, 21.7 cm dbh, 126 years old; ii. Pl, 28.4 cm dbh, 92 years old; iii. Bl, 33.5 cm dbh, 94 years old; iv. Bl, 29.5 cm dbh, 92 years old; v. Se, 32.5 cm dbh, 109 years old; vi. Se, 43.4 cm dbh, 103 years old.

APPENDIX 5 SITE CHARACTERISTICS FOR ADDITIONAL STANDS EXAMINED BUT NOT SAMPLED FOR OLD GROWTH

Variant	Site series	Location	Latitude / longitude	Slope (%)	Aspect (°)	Elevation ranges (m)	Stand age (yr)
ESSFdk	01	No Name Creek[a]	49°05'40" / 114°15'20"	0 - 70	variable	1500 - 1750	170 - 350+
	05 - 06	Steamboat Mountain 5	50°45'20" / 116°16'15"	3 - 8	3	1550	120 - 130
ESSFdk / MSdk	02 - 03	Jubilee Mountain 43	50°55'50" / 116°27'45"	20 - 70	20 - 220	1550 - 1620	90 - 110
ESSFwc1	01	Split Creek 19	49°51'20" / 118°46'30"	5	140	1560	100 - 116
ESSFwm	01	Baker Creek - West	49°36'50" / 116°35'35"	50	3	1450 - 1550	168
	01 - 02	Yahk River	49°11'40" / 115°44'00"	16 - 42	170 - 336	1650 - 1880	90 - 120
	-	Snowcrest Creek[a]	49°34'42" / 116°32'35"	-	variable	1400 - 2800	140 - 251+ [b]
ESSFwm / ICHmw2	-	Baribeau Creek[a]	49°39'50" / 116°36'35"	-	variable	1300 - 2600	140 - 251+ [b]
ESSFwm / MSdk	03	Burton Creek - North + East	49°20'40" / 115°06'50"	40 - 60	variable	1200 - 2100	100 - 140
ICHdw	01a	Granby River 22	49°27'00" / 118°34'00"	25 - 34	8 - 214	1240 - 1300	90 - 180
	02	Grohman Narrows	49°30'40" / 117°21'55"	30 - 50	160 - 190	650 - 1200	100 - 105

Appendix 5 (continued)

Variant	Site series	Location	Latitude / longitude	Slope (%)	Aspect (°)	Elevation ranges (m)	Stand age (yr)
ICHmk1	01	Parsons 3	51°05'20" / 116°43'10"	30	45	915	65 - 75
	03	Moyie South	49°23'45" / 115°52'30"	60 - 90	0 - 190	1050 - 1800	160 - 250
ICHmk1/ ICHmw2	-	Ward Creek[a]	49°03'08" / 115°35'00"	-	variable	1150 - 1800	251+ [b]
ICHmw1	01	Dogtooth 1	51°03'60" / 116°43'10"	10 - 32	34	1320	80 - 100
ICHmw2	01	Bartlett Creek	49°58'20" / 117°20'00"	30 - 60	220 - 240	800 - 900	112
	01 - 02	Granby River 32	49°27'00" / 118°34'00"	2 - 30	70 - 286	1350 - 1480	140 - 200
IDFdm2	01 - 02	Moyie North	49°24'55" / 115°55'00"	50 - 140	160 - 270	1000 - 1450	160 - 250
	01 - 03	South Canal Flats	50°03'45" / 115°46'18"	10 - 20	190 - 360	900 - 1050	120 - 268+
	03	Hahas Lake - West	49°45'15" / 115°50'20"	60	90 - 120	950 -1100	variable
	03	Moyie Floodplain	49°24'40" / 115°54'05"	0 - 2	110 - 130	970 - 1000	170
	03	Miller Road	49°43'30" / 115°44'28"	0 - 5	80 - 90	880 - 900	150 - 200+

Appendix 5 (continued)

Variant	Site series	Location	Latitude / longitude	Slope (%)	Aspect (°)	Elevation ranges (m)	Stand age (yr)
IDFun	-	Syringa Creek	49°20'45" / 117°49'15"	40 - 90	170 - 200	450 - 700	100
IDFxh1	02	Rock Creek North 42	49°07'00" / 119°01'00"	25 - 50	110 - 190	1100 - 1120	110 - 130
	05	Rock Creek West 27	49°02'00" / 119°02'20"	23	352	970	85 - 100
	-	Midway 26	49°01'45" / 118°45'40"	-	-	1100	-
MSdk	01	Steamboat Mountain 3	50°44'40" / 116°16'15"	20	350	1580	102
MSdk	03	Steamboat Mountain 1	50°43'10" / 116°14'20"	50	70	1500	130 - 135
MSdk	03	Steamboat Mountain 4	50°45'00" / 116°16'30"	40 - 65	200 - 340	1590 - 1600	110 - 138
	04	Bugaboo 31	50°51'45" / 116°32'10"	30	140	1250 - 1190	75 - 115
	04	Cartwright Lake 30	50°49'00" / 116°25'20"	8 - 22	188 - 210	1150	115 - 130
MSdm1	01 - 04	Brides Creek 36	49°02'30" / 119°11'00"	20 - 25	50 - 262	1350 - 1460	70 - 130
PPdh1	-	Midway 45	49°01'45" / 118°44'20"	-	-	750	-

Appendix 5 (concluded.)

Variant	Site series	Location	Latitude / longitude	Slope (%)	Aspect (°)	Elevation ranges (m)	Stand age (yr)
PPdh2	01 - 02b	Skookumchuck 7	49°53'30" / 115°43'30"	3	70	850	110 - 130
	01 - 04	Skookumchuck 3	49°55'30" / 115°42'15"	5 - 40	200	880 - 850	100 - 125
	02b	Skookumchuck 4	49°53'15" / 115°41'45"	10	215	850	100 - 130
	02b	Skookumchuck 9	49°50'15" / 115°41'20"	0 - 25	185 - 260	930	110 - 150
	02b - 03	Skookumchuck 1	49°55'15" / 115°44'45"	10 - 30	180 - 260	850 - 830	120 - 130

[a] Stand viewed by helicopter with little, if any, ground truthing.
[b] Age from forest cover map, not verified on ground.

APPENDIX 6 SITES SAMPLED FOR OLD GROWTH: DISTURBANCE AGENTS, WILDLIFE OBSERVATIONS, HUMUS DEPTHS, SUPPRESSED TREES, AND GENERAL COMMENTS

						Disturbances					Wildlife sign				LFH:	B2 -	
Variant	Site series	Location	Plot No.	No. of Layers	Gaps?	Fire?	Diseases?	Insects?	Wind?	Others?	Cavities?	Nests?	Pellets?	Others?	Thickness (cm)	strata vets	Comments
ESSFdk	02	Quinn Creek - North	128	M[a]	Y[b]	N[c]	N	Y	Y	N	N	N	Y	Y[d]	4	0	bark beetle, Se blowdown, ungulate trails, porcupine damage
			129	3	Y	N	N	N	Y	Y	N	N	Y	Y	4	3	ungulate trails/beds, some avalanche damage
			130	M	Y	N	N	N	N	Y	N	N	Y	N	4	0	avalanches, ungulate trail
			131	2	Y	N	N	N	N	Y	N	N	Y	N	2	4	avalanches, ungulate trails
	02-04	Quinn Creek - South	132	M	N	N	N	N	Y	N	N	N	Y	N	2	13	
			133	2	N	N	N	N	N	N	N	N	Y	Y	1	1	ungulate trails
			134	3	Y	N	N	N	Y	N	N	N	Y	Y	1	0	ungulate trails
			135	M	Y	N	N	N	Y	N	N	N	Y	N	3	3	large-diameter Fd in area
ESSFwm	02	Angus Creek	124	M	Y	N	N	N	Y	N	N	N	N	N	6	15	all suppressed (B-vets)
			125	M	Y	N	N	N	Y	N	N	N	N	N	2	37	
			126	3	Y	N	N	N	Y	N	N	N	N	N	2	10	old windthrow, area opened up
			127	M	Y	N	N	N	Y	N	N	N	N	N	4	1	heavy moss layer preventing germination
ICHdw	01b	Almond Creek	230	M	N	N	N	N	N	N	N	N	N	N	2.5	1	suppressed mature
			231	M	N	N	N	N	N	Y	N	N	N	N	2.0	0	select log on edge (selected)
			232	M	Y	N	N	N	Y	Y	N	N	N	N	2.5	1	old Fd, Lw removed
			233	M	N	N	N	N	N	Y	N	N	N	N	2.5	2	old select log in area (no stumps)
	02-01b	Kokanee Creek	10	M	Y	N	N	N	Y	N	N	N	Y	N	5	0	Cw outside plot
			11	M	Y	Y	N	N	Y	N	Y	N	Y	N	3	0	Deer, Fd regeneration nearby
			12	M	Y	Y	Y	N	Y	N	N	N	Y	Y	4	0	bear sign, root rot deer bones
			13	M	Y	N	Y	N	Y	N	Y	N	Y	N	4	0	bear sign, deer sign
	02	Burrell Creek IR	222	2	Y	Y	N	N	N	Y	N	N	N	N	3.0	0	rock outcrops
			223	M	Y	Y	N	N	N	Y	N	N	N	N	2.0	0	rocky
			224	M	Y	N	N	N	N	Y	N	N	N	N	2.0	0	rocky, open
			225	M	Y	N	N	N	N	Y	N	N	N	N	1.5	0	rocky, open

Appendix 6 (continued)

Variant	Site series	Location	Plot No.	No. of Layers	Gaps?	Disturbances					Wildlife sign				LFH: Thickness (cm)	B2 - strata vets	Comments
						Fire?	Diseases?	Insects?	Wind?	Others?	Cavities?	Nests?	Pellets?	Others?			
ICHmk1	02	Wigwam River	112	M	Y	N	N	Y	Y	N	N	N	Y	Y	2	3	bark feeding on Fd, ungulate trails
			113	M	Y	N	Y	Y	Y	N	N	N	Y	N	2	15	ungulate trails, possible edge of root rot centre
			114	M	Y	N	N	N	Y	N	N	N	Y	N	1	18	ungulate trail
			115	3	Y	N	N	N	Y	N	N	N	N	N	1	6	browse, ungulate trails
	04	Lodgepole Creek	116	3	Y	N	N	Y	Y	N	N	N	Y	Y	3	8	woodpeckers feeding on bark beetles
			117	3	Y	N	N	Y	Y	N	N	N	Y	Y	3	3	feeding on bark beetle, game trail
			118	M	Y	N	N	Y	Y	N	N	N	N	Y	3	9	feeding on bark (not all mortality due to beetles - no galleries)
			119	M	Y	N	N	Y	Y	N	N	N	Y	Y	3	3	feeding cavities, game trails
	05-06	Rendell 17	226	M	N	N	N	N	N	N	N	N	Y	N	1.5	0	
			227	M	N	N	N	N	N	N	N	N	N	N	4.5	1	suppressed
			228	M	Y	N	N	N	Y	Y	N	N	N	N	4.0	8	broken tops - snow damage?
			229	M	N	N	N	N	N	N	N	N	N	N	2.0	0	
	06	Parsons 1	214	M	N	N	N	N	N	Y	N	N	N	N	5.0	4	very old logging
			215	M	Y	N	Y	N	N	Y	N	N	N	Y	6.0	0	Ep dieoff, old logging
			216	M	Y	N	Y	N	N	Y	N	N	N	Y	5.0	3	bear scat
			217	M	Y	N	N	N	N	Y	N	N	N	N	5.0	5	Cw rot
ICHmw1	01-04	Dogtooth 2	209	3	Y	Y	Y	N	Y	N	N	N	N	N	2.5	0	root rot
			210	M	Y	Y	N	N	Y	N	N	N	Y	N	2.0	0	
			211	M	Y	Y	Y	N	Y	N	N	N	N	N	2.5	4	root rot
			212	M	Y	Y	Y	N	Y	N	N	N	N	N	2.0	0	root rot, windthrow
ICHmw2	01	Edgewood 34	241	M	N	N	N	N	N	N	N	N	N	N	3.5	2	
			242	M	Y	N	N	N	Y	N	N	N	N	N	2.5	1	
			243	M	N	N	N	N	N	N	N	N	N	N	3.0	0	

Appendix 6 (continued)

Variant	Site series	Location	Plot No.	No. of Layers	Gaps?	Disturbances					Wildlife sign				LFH: Thickness (cm)	B2 - strata vets	Comments
						Fire?	Diseases?	Insects?	Wind?	Others?	Cavities?	Nests?	Pellets?	Others?			
ICHmw2	01	Edgewood 34	244	M	Y	N	N	N	Y	N	N	N	N	N	3.0	1	
		Granby 32	234	M	Y	N	N	N	Y	N	N	N	N	N	9.0	1	edge of small blowdown
			235	M	Y	N	N	N	Y	N	N	N	N	N	5.5	0	
	05	Baker Creek	136	2	Y	N	N	N	Y	N	Y	N	N	N	7	0	
			137	M	N	N	N	N	N	N	N	N	N	Y	7	0	limited game trail, no germinants due to thick LFH
			138	3	Y	N	N	N	Y	Y	N	N	N	N	7	49	
			139	3	Y	N	Y	N	Y	N	N	N	N	N	8	1	
	06	Redding Creek	140	3	Y	N	N	N	Y	N	N	N	Y	Y	3	2	ungulate wallow + trails
			141	M	Y	N	N	N	Y	N	N	N	N	Y	4	4	ungulate trail, blowdown
			142	3	Y	N	N	N	Y	N	N	N	N	N	5	1	blowdown
			143	3	Y	N	N	N	Y	N	N	N	N	N	5	1	
ICHxw	02	Sanca Creek	14	3	Y	Y	Y	N	Y	N	N	N	Y	N	3	0	Ah below, deer sign
			15	M	Y	Y	Y	Y	Y	N	N	N	Y	N	2	0	mistletoe, deer
			16	M	Y	Y	N	Y	Y	N	Y	N	Y	N	1	0	
			17	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	0	0	ants, 7 cm Prunus emarginata,
IDFdm1	01	Midway 35	218	M	Y	Y	N	N	N	Y	N	N	Y	N	1.0	0	old logging, fire
			219	M	Y	Y	N	N	Y	Y	N	N	Y	N	1.5	5	
			220	M	Y	Y	N	N	Y	Y	N	N	Y	N	1.5	2	
			221	M	Y	Y	Y	N	N	N	N	N	Y	N	1.0	0	root rot
IDFdm2	01	Perry Creek - South	104	M	Y	Y	N	N	Y	N	Y	N	Y	Y	5	3	ungulate trail, shallow to bedrock
			1 '	M	Y	Y	N	N	Y	N	N	N	N	N	4	2	old logging, shallow to bedrock
			106	M	Y	Y	N	N	Y	N	N	N	N	N	5	1	
			107	M	Y	Y	N	N	Y	N	Y	N	N	N	6	3	
	02	Burton Creek	120	1	N	N	N	Y	N	N	N	N	N	Y	0	0	skree slope, open, feeding cavities

Appendix 6 (continued)

Variant	Site series	Location	Plot No.	No. of Layers	Gaps?	Disturbances					Wildlife sign				LFH: Thickness (cm)	B2 - strata vets	Comments
						Fire?	Diseases?	Insects?	Wind?	Others?	Cavities?	Nests?	Pellets?	Others?			
IDFdm2	02	Burton Creek	121	M	N	N	N	N	N	N	N	N	Y	Y	1	0	feeding cavities, ungulate trails
			122	3	N	N	N	N	N	N	N	N	Y	Y	2	0	ungulate trails
			123	M	Y	N	N	N	N	Y	N	N	Y	Y	1	0	ungulate trails, some debris from road building above destabilized area
	03	Hahas Lake	144	M	Y	Y	N	N	Y	N	Y	N	Y	N	1	2	
			145	M	Y	Y	N	N	Y	N	Y	Y	Y	N	1	2	many nesting cavities
			146	M	Y	Y	N	N	Y	N	N	N	Y	N	1	6	ungulate trails
			147	M	Y	Y	N	N	Y	N	N	N	Y	N	1	0	
		Perry Creek - North	108	M	Y	Y	N	N	N	Y	N	N	N	Y	5	0	game trails, squirrels, old logging >50 yrs ago
			109	3	Y	Y	N	Y	N	Y	N	N	N	Y	3	0	pine bark beetle (Py), old logging, game trails
			110	M	Y	Y	N	N	Y	Y	N	N	N	Y	6	0	trees damaged by rolling rocks, many squirrels, ungulate trails + beds
			111	2	Y	Y	N	N	N	Y	N	N	N	Y	5	0	rock rolling damage, old logging, game trails + beds
MSdk	03	Premier Ridge 29	205	3	Y	Y	N	N	Y	N	N	N	Y	N	2.0	0	old underburn, windthrow, fire
			206	M	N	Y	N	N	N	N	N	N	Y	N	1.5	0	fire produced dense Fd pockets
			207	M	N	Y	N	Y	N	N	N	N	Y	Y	1.5	12	Fd bark beetle in area
			208	3	N	Y	N	N	N	N	N	N	Y	N	1.0	0	
	04	Cartwright Lake 30	213	M	Y	Y	N	N	Y	N	Y	N	N	N	2.0	4	
MSdm1	04	Rendell Creek - Mouth	236	3	N	N	N	Y	N	N	N	N	Y	N	4.0	1	mpb in area
			237	3	N	N	N	N	N	N	N	N	Y	N	2.5	0	

Appendix 6 (concluded.)

Variant	Site series	Location	Plot No.	No. of Layers	Gaps?	Disturbances			
						Fire?	Dis-eases?	Insects?	Wind?
MSdm1	04	Rendell Creek - Mouth	238	M	Y	Y	N	N	N
			239	M	Y	Y	N	N	N
			240	M	N	N	N	N	N
PPdh2	01	Skookumchuck 2	201	M	N	Y	N	N	N
			202	1	N	Y	N	Y	Y
			203	1	N	Y	N	N	N
			204	1	N	Y	N	N	N
	02b	Lewis Creek	100	2	N	Y	N	N	N
			101	1	N	Y	N	N	N
			102	1	N	Y	N	N	N
			103	2	N	Y	N	N	N

[a] M = multi-layered.
[b] Y = gaps present in canopy; N = gaps not present in canopy.
[c] Y = yes or type of disturbance/wildlife sign present; N = no or type of disturbance/wildlife sign not pres
[d] If others indicated for disturbance or wildlife sign, details in comments.

	Wildlife sign						
Others?	Cavities?	Nests?	Pellets?	Others?	LFH: Thickness (cm)	B2 - strata vets	Comments
Y	N	N	Y	Y	2.5	0	bouldery
N	N	N	N	N	4.5	1	
N	N	N	Y	Y	2.5	4	ungulate trails
N	N	N	Y	N	1.0	1	browse, elk pellets, old fire history
N	N	N	Y	N	1.5	0	old mp beetle attack
Y	N	N	Y	N	2.0	0	juvenile Fd snow press
Y	N	N	Y	N	1.5	0	old logging
N	N	N	Y	Y	3	0	open forest-grassland, Fd present in stand, game trail
N	N	N	Y	N	1	0	open forest - grassland, Fd present
N	N	N	Y	Y	1	0	game trail - browse
N	N	N	Y	Y	3	0	open forest - grassland

ent.

APPENDIX 7 SITES SAMPLED FOR OLD GROWTH: REE CLASS FREQUENCY FOR EACH SITE

This appendix contains a statistical output from SAS. Sites have been sorted by site series within variants. Mean refers to average density of trees >7.5 cm dbh for each site. The frequency of a tree class within each site is indicated by "%". Number of sample plots within each stand (n) are indicated in Table 6 of the main text. Tree classes are described in B.C. Min. Forests (1992d). The codes for site are explained below:

Site	Location	Site	Location
1	Kokanee Creek	14	Quinn Creek - North
2	Sanca Creek	20	Skookumchuck 2
3	Lewis Creek	21	Premier Ridge 29
4	Angus Creek	22	Dogtooth 2
5	Hahas Lake	23	Cartwright Lake 30
6	Perry Creek - South	24	Parsons 1
7	Perry Creek - North	25	Midway 35
8	Burton Creek	26	Burrell Creek 18
9	Baker Creek	27	Rendell 17
10	Redding Creek	28	Almond Creek
11	Lodgepole Creek	29	Granby 32
12	Wigwam River	30	Rendell Creek - Mouth
13	Quinn Creek - South	31	Edgewood 34

Appendix 7 (continued)

Tree class frequency by site within variant and site series
old-growth sampling project
14:53 Friday, May 19, 1995

Variant ESSF	Site series	Site		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha
dk	2	13	mean	500.0	150.0	62.5	.
			%	70.2	21.1	8.8	.
		14	mean	325.0	62.5	87.5	.
			%	68.4	13.2	18.4	.
ES-	2	4	mean	725.0	75.0	50.0	25.0
SF-			%				
ww				82.9	8.6	5.7	2.9
IC-	1B	28	mean	687.5	262.5	62.5	62.5
Hdw			%	64.0	24.4	5.8	5.8
	2	1	mean	425.0	175.0	50.0	62.5
			%	59.6	24.6	7.0	8.8
		26	mean	125.0	31.3	12.5	.
			%	74.1	18.5	7.4	.
IC-	2	12	mean	400.0	87.5	62.5	62.5
Hw-			%	65.3	14.3	10.2	10.2
k1	4	11	mean	662.5	100.0	250.0	.
			%	65.6	9.9	24.7	.
	5	27	mean	500.0	287.5	25.0	75.0
			%	56.3	32.4	2.8	8.5
	6	24	mean	712.5	150.0	50.0	50.0
			%	74.0	15.6	5.2	5.2
IC-	4	22	mean	912.5	125.0	125.0	262.5
Hw-			%				
w1				64.0	8.8	8.8	18.4
IC-	1	29	mean	600.0	75.0	25.0	25.0
Hw-			%	82.8	10.3	3.4	3.4
w2		31	mean	412.5	162.5	62.5	62.5
			%	58.9	23.2	8.9	8.9
IC-	5	9	mean	300.0	62.5	112.5	75.0
Hw-			%	54.5	11.4	20.5	13.6
m2	6	10	mean	475.0	25.0	125.0	37.5
			%	71.7	3.8	18.9	5.7
IC-	2	2	mean	100.0	175.0	12.5	43.7
Hxw			%	30.2	52.8	3.8	13.2
ID-	1	25	mean	425.0	112.5	75.0	12.5
Fd-			%				
w1				68.0	18.0	12.0	2.0

Appendix 7 (concluded.)

Tree class frequency by site within variant and site series
old-growth sampling project
14:53 Friday, May 19, 1995

Variant	Site series	Site		Tree class: Residual stems/ha	Suspect stems/ha	Dead potential stems/ha	Dead useless stems/ha
IDFd2	1	6	mean	712.5	25.0	75.0	37.5
			%	83.8	2.9	8.8	4.4
	2	8	mean	206.3	18.8	6.2	6.2
			%	86.8	7.9	2.6	2.6
	3	5	mean	281.3	37.5	.	12.5
			%	84.9	11.3	.	3.8
		7	mean	431.3	43.7	18.8	.
			%	87.3	8.9	3.8	.
MSdk	3	21	mean	243.8	25.0	6.2	6.2
			%	86.7	8.9	2.2	2.2
	4	23	mean	525.0	25.0	.	75.0
			%	84.0	4.0	.	12.0
MSdm1	4	30	mean	490.0	80.0	35.0	35.0
			%	76.6	12.5	5.5	5.5
PPch2	1	20	mean	356.3	18.8	12.5	.
			%	91.9	4.8	3.2	.
	28	3	mean	162.5	18.8	6.2	.
			%	86.7	10.0	3.3	.

APPENDIX 8 SITES SAMPLED FOR OLD GROWTH: WILDLIFE TREE CLASS FREQUENCY FOR EACH SITE

This appendix contains a statistical output from SAS. Sites have been sorted by site series within variants. Mean refers to average density of trees >7.5 cm dbh for each site. The frequency of a wildlife tree class within each site is indicated by "%". Number of sample plots within each stand (n) are indicated in Table 6 of the main text. Snag class equals wildlife tree class. These classes are described in Backhouse (1993) or Thomas et al. (1979). The codes for site are explained below:

Site	Location	Site	Location
1	Kokanee Creek	14	Quinn Creek - North
2	Sanca Creek	20	Skookumchuck 2
3	Lewis Creek	21	Premier Ridge 29
4	Angus Creek	22	Dogtooth 2
5	Hahas Lake	23	Cartwright Lake 30
6	Perry Creek - South	24	Parsons 1
7	Perry Creek - North	25	Midway 35
8	Burton Creek	26	Burrell Creek 18
9	Baker Creek	27	Rendell 17
10	Redding Creek	28	Almond Creek
11	Lodgepole Creek	29	Granby 32
12	Wigwam River	30	Rendell Creek - Mouth
13	Quinn Creek - South	31	Edgewood 34

Appendix 8 (continued)

Snag class frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant	Site series	Site		Snag class 1 stems/ha	2 stems/ha	3 stems/ha	4 stems/ha	5 stems/ha	6 stems/ha	7 stems/ha
ESSFdk	2	13	mean	500.0	150.0	62.5	.	.	.	.
			%	70.2	21.1	8.8	.	.	.	.
		14	mean	325.0	62.5	62.5	25.0	.	.	.
			%	68.4	13.2	13.2	5.3	.	.	.
ESSFvm	2	4	mean	725.0	75.0	12.5	37.5	.	25.0	.
			%	82.9	8.6	1.4	4.3	.	2.9	.
ICHdw	18	28	mean	687.5	262.5	50.0	12.5	.	50.0	12.5
			%	66.0	24.6	4.7	1.2	.	4.7	1.2
	2	1	mean	425.0	175.0	50.0	.	.	62.5	.
			%	59.6	24.6	7.0	.	.	8.8	.
		26	mean	125.0	31.3	12.5	.	.	.	.
			%	74.1	18.5	7.4	.	.	.	.
ICHmk1	2	12	mean	400.0	87.5	25.0	37.5	62.5	.	.
			%	65.3	14.3	4.1	6.1	10.2	.	.
	4	11	mean	662.5	100.0	187.5	62.5	.	.	.
			%	65.4	9.9	18.5	6.2	.	.	.
	5	27	mean	500.0	287.5	25.0	.	25.0	50.0	.
			%	56.3	32.4	2.8	.	2.8	5.6	.
	6	24	mean	712.5	150.0	37.5	12.5	37.5	12.5	.
			%	74.0	15.6	3.9	1.3	3.9	1.3	.
ICHmw1	4	22	mean	912.5	125.0	75.0	50.0	162.5	100.0	.
			%	64.0	8.8	5.3	3.5	11.4	7.0	.
ICHmw2	1	29	mean	600.0	75.0	25.0	.	.	25.0	.
			%	82.8	10.3	3.4	.	.	3.4	.
		31	mean	412.5	162.5	62.5	.	12.5	50.0	.
			%	58.9	23.2	8.9	.	1.8	7.1	.
ICHmw2	5	9	mean	300.0	62.5	100.0	12.5	.	75.0	.
			%	54.5	11.4	18.2	2.3	.	13.6	.
	6	10	mean	475.0	25.0	100.0	25.0	12.5	25.0	.
			%	71.7	3.8	15.1	3.8	1.9	3.8	.
ICHxw	2	2	mean	100.0	175.0	6.2	6.2	6.2	25.0	12.5
			%	30.2	52.8	1.9	1.9	1.9	7.5	3.8
IDFdm1	1	25	mean	425.0	112.5	62.5	12.5	12.5	.	.
			%	68.0	18.0	10.0	2.0	2.0	.	.

Appendix 8 (concluded.)

Snag class frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant ID-Fd-	Site series	Site		Snag class 1 stems/-ha	2 stems/-ha	3 stems/-ha	4 stems/-ha	5 stems/-ha	6 stems/-ha	7 stems/-ha
wa2	1	6	mean	712.5	25.0	62.5	12.5	37.5	.	.
			%	83.8	2.9	7.4	1.5	4.4	.	.
	2	8	mean	206.3	18.8	6.2	.	.	6.2	.
			%	86.8	7.9	2.6	.	.	2.6	.
	3	5	mean	281.3	37.5	.	.	.	12.5	.
			%	84.9	11.3	.	.	.	3.8	.
		7	mean	431.3	43.7	18.8	.	.	.	.
			%	87.3	8.9	3.8	.	.	.	.
HS-dk	3	21	mean	243.8	25.0	.	6.2	.	6.2	.
			%	86.7	8.9	.	2.2	.	2.2	.
	4	23	mean	525.0	25.0	.	.	25.0	50.0	.
			%	84.0	4.0	.	.	4.0	8.0	.
HS-dm1	4	30	mean	490.0	80.0	10.0	25.0	35.0	.	.
			%	76.6	12.5	1.6	3.9	5.5	.	.
PP-dh2	1	20	mean	356.3	18.8	12.5	.	.	.	.
			%	91.9	4.8	3.2	.	.	.	.
	28	3	mean	162.5	18.8	.	6.2	.	.	.
			%	86.7	10.0	.	3.3	.	.	.

APPENDIX 9 SITES SAMPLED FOR OLD GROWTH: TREE SPECIES FREQUENCY FOR EACH SITE

This appendix contains a statistical output from SAS. Sites have been sorted by site series within variants. Mean refers to average density of trees >7.5 cm dbh for each site. The frequency of a tree species within each site is indicated by "%". Number of sample plots within each stand (n) are indicated in Table 6 of the main text. The codes for site are explained below:

Site	Location	Site	Location
1	Kokanee Creek	14	Quinn Creek - North
2	Sanca Creek	20	Skookumchuck 2
3	Lewis Creek	21	Premier Ridge 29
4	Angus Creek	22	Dogtooth 2
5	Hahas Lake	23	Cartwright Lake 30
6	Perry Creek - South	24	Parsons 1
7	Perry Creek - North	25	Midway 35
8	Burton Creek	26	Burrell Creek 18
9	Baker Creek	27	Rendell 17
10	Redding Creek	28	Almond Creek
11	Lodgepole Creek	29	Granby 32
12	Wigwam River	30	Rendell Creek - Mouth
13	Quinn Creek - South	31	Edgewood 34

Appendix 9 (continued)

Tree species frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant ESSF-	Site series	Site		Tree species: Populus trichocarpa stems/ha	Populus tremuloides stems/ha	Abies lasiocarpa stems/ha	Thuja plicata stems/ha	Betula papyrifera stems/ha	Pseudotsuga menziesii stems/ha	Tsuga heterophylla stems/ha
dk	2	13	mean	.	.	225.0	.	.	312.5	.
			%	.	.	31.6	.	.	43.9	.
		14	mean	.	.	200.0	.	.	37.5	.
			%	.	.	42.1	.	.	7.9	.
ES-	2	4	mean	.	.	637.5	.	.	.	.
SF-			%							
wm				.	.	72.9	.	.	.	.
IC-	18	28	mean	.	.	.	362.5	.	.	675.0
Hdw			%	.	.	.	33.7	.	.	62.8
	2	1	mean	12.5	.	.	225.0	50.0	275.0	12.5
			%	1.8	.	.	31.6	7.0	38.6	1.8
		26	mean	.	.	.	.	.	168.8	.
			%	.	.	.	.	.	100.0	.
IC-	2	12	mean	.	25.0	.	.	.	500.0	.
Hw-			%	.	4.1	.	.	.	81.6	.
k1	4	11	mean	.	.	287.5	12.5	.	100.0	.
			%	.	.	28.4	1.2	.	9.9	.
	5	27	mean	.	.	100.0	212.5	.	25.0	437.5
			%	.	.	11.3	23.9	.	2.8	49.3
	6	24	mean	.	.	112.5	462.5	125.0	.	12.5
			%	.	.	11.7	48.1	13.0	.	1.3
IC-	4	22	mean	.	.	912.5	.	.	187.5	.
Hw-			%							
w1				.	.	64.0	.	.	13.2	.
IC-	1	29	mean	.	.	425.0	75.0	.	25.0	50.0
Hw-			%	.	.	58.6	10.3	.	3.4	6.9
w2		31	mean	.	.	112.5	162.5	.	.	412.5
			%	.	.	16.1	23.2	.	.	58.9
IC-	5	9	mean	.	.	25.0	87.5	.	.	437.5
Hw-			%	.	.	4.5	15.9	.	.	79.5
w2	6	10	mean	.	.	125.0	37.5	.	.	137.5
			%	.	.	18.9	5.7	.	.	20.8
IC-	2	2	mean	.	.	.	.	.	243.8	.
Hxw			%	.	.	.	.	.	73.6	.

Appendix 9 (continued)

Tree species frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant	Site series	Site		Populus trichocarpa stems/ha	Populus tremuloides stems/ha	Abies lasiocarpa stems/ha	Thuja plicata stems/ha	Betula papyrifera stems/ha	Pseudotsuga menziesii stems/ha	Tsuga heterophylla stems/ha
IDFd1	1	25	mean	.	12.5	.	.	.	487.5	.
			%	.	2.0	.	.	.	78.0	.
IDFd2	1	6	mean	.	.	25.0	87.5	.	462.5	.
			%	.	.	2.9	10.3	.	54.4	.
	2	8	mean	.	.	.	.	.	212.5	.
			%	.	.	.	.	.	89.5	.
	3	5	mean	.	.	.	.	.	287.5	.
			%	.	.	.	.	.	86.8	.
		7	mean	.	.	.	.	.	443.8	.
			%	.	.	.	.	.	89.9	.
MSdk	3	21	mean	.	.	.	.	.	281.3	.
			%	.	.	.	.	.	100.0	.
	4	23	mean	.	.	50.0	.	.	400.0	.
			%	.	.	8.0	.	.	64.0	.
MSdm1	4	30	mean	.	.	.	5.0	55.0	180.0	.
			%	.	.	.	0.8	8.6	28.1	.
PPch2	1	20	mean	.	.	.	.	.	75.0	.
			%	.	.	.	.	.	19.4	.
	28	3	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.

Appendix 9 (continued)

Tree species frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant ESSF	Site series			Larix occidentalis stems/ha	Acer glabrum stems/ha	Pinus albicaulis stems/ha	Pinus flexilis stems/ha	Pinus contorta stems/ha	Pinus monticola stems/ha	Pinus ponderosa stems/ha
dk	2	13	mean	.	.	.	.	137.5	.	.
			%	.	.	.	.	19.3	.	.
		14	mean	.	.	.	25.0	.	.	.
			%	.	.	.	5.3	.	.	.
ESSF-wm	2	4	mean	.	.	112.5	.	.	.	.
			%	.	.	12.9	.	.	.	.
ICHdw	18	28	mean	12.5	.	.	.	.	12.5	.
			%	1.2	.	.	.	.	1.2	.
	2	1	mean	.	37.5	.	.	.	.	100.0
			%	.	5.3	.	.	.	.	14.0
		26	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.
ICHmk1	2	12	mean	.	.	.	.	75.0	.	12.5
			%	.	.	.	.	12.2	.	2.0
	4	11	mean	12.5	.	387.5	.	112.5	.	.
			%	1.2	.	38.3	.	11.1	.	.
	5	27	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.
	6	24	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.
ICHmw1	4	22	mean	.	.	125.0	.	.	.	.
			%	.	.	8.8	.	.	.	.
ICHmw2	1	29	mean	75.0	.	.	.	.	25.0	.
			%	10.3	.	.	.	.	3.4	.
		31	mean	12.5	.	.	.	.	.	.
			%	1.8	.	.	.	.	.	.
ICHmw2	5	9	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.
	6	10	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.
ICHxw	2	2	mean	.	.	.	.	.	.	87.5
			%	.	.	.	.	.	.	26.4
IDFdm1	1	25	mean	112.5	.	.	.	12.5	.	.
			%	18.0	.	.	.	2.0	.	.

Appendix 9 (continued)

Tree species frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant	Site series	Site ID		Larix occidentalis stems/ha	Acer glabrum stems/ha	Pinus albicaulis stems/ha	Pinus flexilis stems/ha	Pinus contorta stems/ha	Pinus monticola stems/ha	Pinus ponderosa stems/ha
Tree species										
ms2dk	1	6	mean	137.5	.	.	.	62.5	.	.
			%	16.2	.	.	.	7.4	.	.
	2	8	mean	.	.	.	.	.	.	25.0
			%	.	.	.	.	.	.	10.5
	3	5	mean	.	.	.	.	.	.	43.7
			%	.	.	.	.	.	.	13.2
		7	mean	.	.	.	.	.	.	50.0
			%	.	.	.	.	.	.	10.1
	3	21	mean	.	.	.	.	.	.	.
			%	.	.	.	.	.	.	.
	4	23	mean	.	.	.	.	75.0	.	.
			%	.	.	.	.	12.0	.	.
ms4dk1	4	30	mean	185.0	.	.	.	165.0	.	.
			%	28.9	.	.	.	25.8	.	.
pp2dh2	1	20	mean	.	.	.	.	56.2	.	256.3
			%	.	.	.	.	14.5	.	66.1
	28	3	mean	.	.	.	.	.	.	187.5
			%	.	.	.	.	.	.	100.0

Appendix 9 (continued)

Tree species frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant ESSF-	Site series	Site		Tree species: Picea engelmannii stems/-ha	Tree species: Picea glauca x engelmannii stems/-ha
dk	2	13	mean	37.5	.
			%	5.3	.
		14	mean	212.5	.
			%	44.7	.
ESSF-wm	2	4	mean	125.0	.
			%	14.3	.
ICHdw	18	28	mean	.	12.5
			%	.	1.2
	2	1	mean	.	.
			%	.	.
		26	mean	.	.
			%	.	.
ICHmk1	2	12	mean	.	.
			%	.	.
	4	11	mean	.	100.0
			%	.	9.9
	5	27	mean	.	112.5
			%	.	12.7
	6	24	mean	.	250.0
			%	.	26.0
ICHmw1	4	22	mean	.	200.0
			%	.	14.0
ICHmw2	1	29	mean	.	50.0
			%	.	6.9
		31	mean	.	.
			%	.	.
ICHwm2	5	9	mean	.	.
			%	.	.
	6	10	mean	.	362.5
			%	.	54.7
ICHxw	2	2	mean	.	.
			%	.	.

Appendix 9 (concluded.)

Tree species frequency by site within variant and site series
old-growth sampling project
14:29 Monday, May 15, 1995

Variant	Site series	Site		Tree species: Picea engelmannii stems/ha	Tree species: Picea glauca x engelmannii stems/ha
ID-Fd-a1	1	25	mean	.	.
			%	.	.
ID-Fd-a2	1	6	mean	.	75.0
			%	.	8.8
	2	8	mean	.	.
			%	.	.
	3	5	mean	.	.
			%	.	.
		7	mean	.	.
			%	.	.
MS-dk	3	21	mean	.	.
			%	.	.
	4	23	mean	.	100.0
			%	.	16.0
MS-dm1	4	30	mean	.	50.0
			%	.	7.8
PP-dh2	1	20	mean	.	.
			%	.	.
	28	3	mean	.	.
			%	.	.

APPENDIX 10 SITES SAMPLED FOR OLD GROWTH: SUMMARY STATISTICS FOR TREE GERMINANTS ON EACH SITE

This appendix contains a statistical output from SAS. Sites have been sorted by site series within variants. Mean refers to average density of germinants (stems/ha) for each site, se refers to standard error of the mean, and n refers to number of plots sampled on a site. The codes for site are explained below:

Site	Location	Site	Location
1	Kokanee Creek	14	Quinn Creek - North
2	Sanca Creek	20	Skookumchuck 2
3	Lewis Creek	21	Premier Ridge 29
4	Angus Creek	22	Dogtooth 2
5	Hahas Lake	23	Cartwright Lake 30
6	Perry Creek - South	24	Parsons 1
7	Perry Creek - North	25	Midway 35
8	Burton Creek	26	Burrell Creek 18
9	Baker Creek	27	Rendell 17
10	Redding Creek	28	Almond Creek
11	Lodgepole Creek	29	Granby 32
12	Wigwam River	30	Rendell Creek - Mouth
13	Quinn Creek - South	31	Edgewood 34

Appendix 10 (continued)

Summary statistics for tree germinants, based on plot means
for each site sampled, sorted by variant and site series
14:29 Monday, May 15, 1995

Variant	Site series	Site		Abies grandis	Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Tsuga heterophylla	Pinus albicaulis
ESSFdk	2	13	mean	0	5375	0	2375	0	0
			se	0.0	2703.2	0.0	1908.0	0.0	0.0
			n	4	4	4	4	4	4
		14	mean	0	1625	0	375	0	0
			se	0.0	850.9	0.0	375.0	0.0	0.0
			n	4	4	4	4	4	4
ESSFwk	2	4	mean	0	7250	0	0	0	750
			se	0.0	6587.6	0.0	0.0	0.0	750.0
			n	4	4	4	4	4	4
ICHdk	18	28	mean	6875	0	500	0	0	0
			se	6226.2	0.0	204.1	0.0	0.0	0.0
			n	4	4	4	4	4	4
	2	1	mean	125	0	375	1875	0	0
			se	125.0	0.0	375.0	1712.6	0.0	0.0
			n	4	4	4	4	4	4
		26	mean	0	0	0	2000	0	0
			se	0.0	0.0	0.0	1414.2	0.0	0.0
			n	4	4	4	4	4	4
ICHmk1	2	12	mean	0	0	0	5000	0	0
			se	0.0	0.0	0.0	1744.0	0.0	0.0
			n	4	4	4	4	4	4
	4	11	mean	0	1250	0	3125	0	0
			se	0.0	595.1	0.0	1346.4	0.0	0.0
			n	4	4	4	4	4	4
	5	27	mean	5250	3000	1875	0	0	0
			se	3430.9	2010.4	1125.0	0.0	0.0	0.0
			n	4	4	4	4	4	4
	6	24	mean	0	125	2250	0	0	0
			se	0.0	125.0	1030.8	0.0	0.0	0.0
			n	4	4	4	4	4	4
ICHmw1	4	22	mean	0	4750	0	0	0	125
			se	0.0	2393.6	0.0	0.0	0.0	125.0
			n	4	4	4	4	4	4
ICHmw2	1	29	mean	0	750	750	0	0	0
			se	0.0	750.0	750.0	0.0	0.0	0.0
			n	2	2	2	2	2	2
		31	mean	625	750	0	0	0	0
			se	473.2	433.0	0.0	0.0	0.0	0.0
			n	4	4	4	4	4	4

Appendix 10 (continued)

Summary statistics for tree germinants, based on plot means for each site sampled, sorted by variant and site series
14:29 Monday, May 15, 1995

Variant	Site series	Site		Abies grandis	Abies lasiocarpa	Thuja plicata	Pseudotsuga menziesii	Tsuga heterophylla	Pinus albicaulis
IC-Hwm2	5	9	mean	0	0	0	0	1375	0
			se	0.0	0.0	0.0	0.0	850.9	0.0
			n	4	4	4	4	4	4
	6	10	mean	0	125	0	0	375	0
			se	0.0	125.0	0.0	0.0	375.0	0.0
			n	4	4	4	4	4	4
IC-Hxw	2	2	mean	0	0	0	625	0	0
			se	0.0	0.0	0.0	375.0	0.0	0.0
			n	4	4	4	4	4	4
ID-Fdm1	1	25	mean	0	0	0	3750	0	0
			se	0.0	0.0	0.0	2086.7	0.0	0.0
			n	4	4	4	4	4	4
ID-Fdm2	1	6	mean	0	0	0	250	0	0
			se	0.0	0.0	0.0	144.3	0.0	0.0
			n	4	4	4	4	4	4
	2	8	mean	0	0	0	125	0	0
			se	0.0	0.0	0.0	125.0	0.0	0.0
			n	4	4	4	4	4	4
	3	5	mean	0	0	0	2625	0	0
			se	0.0	0.0	0.0	718.1	0.0	0.0
			n	4	4	4	4	4	4
		7	mean	0	0	0	0	0	0
			se	0.0	0.0	0.0	0.0	0.0	0.0
			n	4	4	4	4	4	4
MS-dk	3	21	mean	0	0	0	8250	0	0
			se	0.0	0.0	0.0	6342.6	0.0	0.0
			n	4	4	4	4	4	4
	4	23	mean	0	0	0	30500	0	0
			se	.	.	.	.	.	.
			n	1	1	1	1	1	1
MS-dm1	4	30	mean	0	0	0	3200	0	0
			se	0.0	0.0	0.0	2245.0	0.0	0.0
			n	5	5	5	5	5	5
PP-dh2	1	20	mean	0	0	0	7750	0	0
			se	0.0	0.0	0.0	5088.8	0.0	0.0
			n	4	4	4	4	4	4
	2B	3	mean	0	0	0	875	0	0
			se	0.0	0.0	0.0	375.0	0.0	0.0
			n	4	4	4	4	4	4

Appendix 10 (continued)

Summary statistics for tree germinants, based on plot means
for each site sampled, sorted by variant and site series
14:29 Monday, May 15, 1995

Variant	Site series	Site		Pinus contorta	Pinus monticola	Pinus ponderosa	Picea engelmannii	Picea glauca x engelmannii
ESSFdk	2	13	mean	0	0	0	125	0
			se	0.0	0.0	0.0	125.0	0.0
			n	4	4	4	4	4
		14	mean	0	0	0	1250	0
			se	0.0	0.0	0.0	946.5	0.0
			n	4	4	4	4	4
ESSFwk	2	4	mean	0	0	0	0	0
			se	0.0	0.0	0.0	0.0	0.0
			n	4	4	4	4	4
ICHdk	18	28	mean	0	125	0	.	0
			se	0.0	125.0	0.0	.	0.0
			n	4	4	4	0	4
	2	1	mean	0	125	0	.	0
			se	0.0	125.0	0.0	.	0.0
			n	4	4	4	0	4
		26	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
ICHmk1	2	12	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
	4	11	mean	125	0	0	.	125
			se	125.0	0.0	0.0	.	125.0
			n	4	4	4	0	4
	5	27	mean	0	0	0	.	500
			se	0.0	0.0	0.0	.	500.0
			n	4	4	4	0	4
	6	24	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
ICHmw1	4	22	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
ICHmw2	1	29	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	2	2	2	0	2
		31	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4

Appendix 10 (concluded.)

Summary statistics for tree germinants, based on plot means for each site sampled, sorted by variant and site series
14:29 Monday, May 15, 1995

Variant	Site series	Site		Pinus contorta	Pinus monticola	Pinus ponderosa	Picea engelmannii	Picea glauca x engelmannii
ICHm2	5	9	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
	6	10	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
ICHxw	2	2	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
IDFm1	1	25	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
IDFm2	1	6	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
	2	8	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
	3	5	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
		7	mean	0	0	125	.	0
			se	0.0	0.0	125.0	.	0.0
			n	4	4	4	0	4
MSdk	3	21	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	4	4	4	0	4
	4	23	mean	0	0	0	.	0
			se	.	.	.	.	.
			n	1	1	1	0	1
MSdm1	4	30	mean	0	0	0	.	0
			se	0.0	0.0	0.0	.	0.0
			n	5	5	5	0	5
PPdh2	1	20	mean	0	0	500	.	0
			se	0.0	0.0	204.1	.	0.0
			n	4	4	4	0	4
	28	3	mean	0	0	375	.	0
			se	0.0	0.0	239.4	.	0.0
			n	4	4	4	0	4

7 REFERENCES

Arno, S. F. 1980. Forest fire history in the Northern Rockies. J For. 78:460-65.

Avery, T. E. 1975. Natural resources measurements. 2nd ed. McGraw-Hill Book Company, New York.

Backhouse, F. (compiler). 1993. Wildlife tree management in British Columbia. Workers' Compensation Board, B.C. Silviculture Branch, and Canada-British Columbia Partnership Agreement on Forest Resource Development: FRDA II.

Barrett, S. W., S. F. Arno, and C. H. Key. 1991. Fire regimes of western larch–lodgepole pine forests in Glacier National Park, Montana. Can. J. For. Res. 21:1711-20.

B.C. Ministry of Forests. 1992a. An Old Growth Strategy for British Columbia. Report by Old-Growth Task Force, May 1992. Queen's Printer, Victoria, B.C.

B.C. Ministry of Forests. 1992b. Okanagan Timber Supply Area–intergrated resource management timber harvesting guidelines. B.C. Forest Service, Salmon Arm, Vernon, and Penticton, B.C.

B.C. Ministry of Forests. 1992c. An old growth conservation strategy for the Robson Valley Forest District. B.C. Min. For., McBride, B.C.

B.C. Ministry of Forests. 1992d. Forest classification/sampling & environmentally sensitive areas—forest classification. *In* Inventory Manual, B.C. Min. For., Victoria.

B.C. Ministry of Forests, Res. Br. 1990. Old-growth forests: problem analysis. Draft report. Victoria, B.C.

B.C. Ministry of Forests and BC Environment. 1995. Biodiversity guidebook—Forest Practices Code of British Columbia. Victoria.

Braumandl, T. F. Personal communication, October 1992.

Braumandl, T. F. and M. P. Curran (compilers and editors). 1992. A field guide for site identification and interpretation for the NFR. B.C. Min. For., Res. Branch, Land. Manage. Handb. No. 20. Victoria, B.C.

Bunnell, F. L. and A. Allaye-Chan. 1987. Potential of winter range reserves for ungulates as habitat for cavity-nesting birds. *In* Fish and wildlife relationships in old-growth forests. W. R. Meehan, T. R. Merrell, and T. A. Hanley (editors). Proc. of symposium held April 12-15, 1987 at Juneau, Alaska. pp. 357-65.

Carmanah Valley Forest Management Advisory Committee. 1992. Forest management in the upper Carmanah Valley: recommendations of the Public Advisory Committee. Report to the B.C. Ministry of Forests, Victoria, B.C.

Coastal Biodiversity Guidelines Committee. 1992. Guidelines to maintain biological diversity in coastal forests. Draft report. B.C. Min. For. and B.C. Min. of Environ., Lands and Parks.

Day, R. J. 1972. Stand structure, succession, and use of southern Alberta's Rocky Mountain forest. Ecology 53:472-78.

Demarchi, D. A., R. D. Marsh, A. P. Harcombe, and E. C. Lea. 1990. The environment (of British Columbia). *In* The birds of British Columbia, Vol. 1. R. W. Campbell, N. K. Dawes, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, and C. E. McNazz (eds.). Royal British Columbia Museum, Victoria, B.C. pp. 55-142.

Franklin, J. F and M. A. Hemstrom. 1981. Aspects of succession in the coniferous forests of the Pacific Northwest. *In* Forest succession—concepts and application. D. C. West, H. H. Shugart, and D. B. Botkin (editors). Springer-Verlag, New York. pp. 212-29.

Franklin, J. F., K. Cromack, Jr., W. Dension, A. McKee, C. Maser, J. Sedell, F. Swanson, and G. Juday. 1981. Ecological characteristics of old-growth Douglas-fir forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-118, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Freese, F. 1962. Elementary forest sampling. U.S. Dep. Agric. For. Serv., Agr. Handbook No. 232. Reprinted in 1992 by O.S.U. Book Stores, Inc., Corvallis, Oregon.

Goward, T. 1994. Notes on oldgrowth-dependent epiphytic macrolichens in inland British Columbia, Canada. Acta Bot. Fennica 150:31-38.

Green, P., J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1992. Old-growth forest types of the Northern Region. U.S. Dep. Agric. For. Serv., Report R-1 SES 4/92, Northern Region, Missoula, Montana.

Habeck, J. R. 1968. Forest succession in the Glacier Park cedar-hemlock forests. Ecology 49:872-80.

Habeck, J. R. 1978. A study of climax western redcedar (*Thuja plicata* Donn.) forest communities in the Selway - Bitterroot Wilderness, Idaho Northwest Science 52: 67-76.

Habeck, J. R. 1990. Old-growth ponderosa pine-western larch forests in western Montana: ecology and management. The Northwest Environmental Journal 6:271-92.

Hamilton, E. H. and J. Pojar. 1991. Old growth forests in British Columbia. *In* Proc. of the XIX IUFRO World Congress held 5-11, August 1990 at Montreal, Canada. pp. 450-57.

Harmon, M. E., J. F. Franklin, F. J. Swanson, P. Sollins, S. V Gregory, J. D. Lattin, N. H. Anderson, S. P. Cline, N. G. Aumen, J. R. Sedell, G. W Lienkaemper, K. Cromack, Jr., and K. W. Cummins. 1986. Ecology of coarse woody debris in temperate ecosystems. Adv. Ecol. Res. 15:133-301.

Hemstrom, M. A. and J. F. Franklin. 1982. Fire and other disturbances of the forests in Mount Rainier National Park. Quaternary Research 18:32-51.

Hessburg, P. F., R. G. Mitchell, and G. M. Filip. 1994. Historical and current roles of insects and pathogens in Eastern Oregon and Washington forested landscapes. U.S. Dep. Agric. For. Serv., Pac. N.W. For. Range Exp. Sta., Gen. Tech. Rept. PNW-GTR-327. Portland, Oregon.

Hopkins, B., S. Simon, M. Schafer, and T. Lillybridge. 1992. Interim old growth definition for ponderosa pine series. U.S. Dep. Agric. For. Serv., Region 6. Draft publication.

Hunter, M. L., Jr. 1990. Wildlife, forests, and forestry—principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, New Jersey.

Husch, B., C. I. Miller, and T. W. Beers. 1972. Forest mensuration. 2nd ed. John Wiley & Sons, New York.

Johnson, E. A. and G. I. Fryer. 1989. Population dynamics in lodgepole pine–Engelmann spruce forests. Ecology 70: 1335-45.

Kneeshaw, D. D. 1992. Tree population dynamics of some old sub-boreal spruce stands. M.Sc. thesis. University of British Columbia, Vancouver, B.C.

Lehmkuhl, J. F., P. F. Hessburg, R. L. Everett, M. H. Huff, and R. D. Ottmar. 1994. Historical and current forest landscapes of Eastern Oregon and Washington. Part I: vegetation pattern and insect and disease hazards. U.S. Dep. Agric. For. Serv., Pac. N.W. For. Range Exp. Sta., Gen. Tech. Rept. PNW-GTR-328. Portland, Oregon.

Lloyd D., K. Angove, G. Hope, and C. Thompson. 1990. A guide to site identification and interpretation for the Kamloops Forest Region. B.C. Min. For., Res. Branch, Land Manage. Handb. No. 23. Victoria, B.C.

Lunan, J. S. and J. R. Habeck. 1973. The effects of fire exclusion on ponderosa pine communities in Glacier National Park, Montana. Can. J. For. Res. 3:574-79.

Luttmerding, H. A., D. A. Demarchi, E. C. Lea, D. V. Meidinger, and T. Vold (editors). 1990. Describing ecosystems in the field. Second edition. B.C. Min. For. and B.C. Min. Environ, MOE Manual 11. Victoria, B.C.

Mannan, R. W. and E. C. Meslow. 1984. Bird populations and vegetation characteristics in managed and old-growth forests, northeastern Oregon. J. Wildl. Manage. 48:1219-38.

Maser, C., R. G. Anderson, K. Cromack, Jr., J. T. Williams, and R. E. Martin. 1979. Dead and down woody material. *In* Wildlife habitats in managed forests—the Blue Mountains of Oregon and Washington. J. W. Thomas (technical editor). U.S. Dep. Agric. For. Serv., Agric. Handb. No. 553, Portland, Oregon. pp. 78-95.

Meidinger, D. and J. Pojar (compilers and editors). 1991. Ecosystems of British Columbia. B.C. Min. For., Res. Branch, Special Report Series 6. Victoria, B.C.

Moeur, M. 1992. Baseline demographics of late successional western hemlock/western redcedar stands in northern Idaho Research Natural Areas. U.S. Dep. Agric. For. Serv., Res. Pap. INT-456, Intermountain Research Station, Ogden, Utah.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, Inc., New York.

O'Laughlin, J., J. G. MacCracken, D. L. Adams, S. C. Bunting, K. A. Blatner, and C. E. Keegan, III. 1993. Forest health conditions in Idaho. Rept. No. 11, Idaho Forest, Wildlife and Range Policy Analysis Group, University of Idaho, Boise

Oliver, C. D. and B.C. Larson. 1990. Forest stand dynamics. McGraw-Hill, Inc. New York, New York.

Oliver, W. W. and R. A. Ryker. 1990. *Pinus ponderosa* Dougl. ex Laws. Ponderosa pine. *In* Silvics of North America. Volume 1. Conifers. R. M. Burns and B. H. Honkala (technical co-ordinators). U.S. Dep. Agric. For. Serv., Agric. Handb. 654. pp. 413-24.

Pojar, J. 1991. Old growth forests in British Columbia. *In* Applications in a changing world. H. Schrier, H. S. Brown, P. O'Reilly, and P. Meehan (editors). Proc. of GIS '91 Symposium held February 12-15, 1991 at Vancouver, B.C. pp. 15-21.

Pojar, J., E. Hamilton, D. Meidinger, and A. Nicholson. 1990. Old growth forests and biological diversity in British Columbia. *In* Landscape ecology and management symposium. G. B. Ingram and M. R. Moss (editors). Held at University of B.C., May 4-5, 1990. Vancouver, B.C. pp. 85-97.

Pojar, J., K. Klinka, and D. V. Meidinger. 1987. Biogeoclimatic ecosystem classification in British Columbia. For. Ecol. Manage. 22:119-54.

Quesnel, H. J. and J. K. Leahy. 1993. Forests greater than 140 years old in the Kootenay-Boundary Region—status report. Tech. Rept. TR-004, B.C. Min. For., Forest Sciences and Planning Sections, Nelson, B.C.

Quesnel, H. J. and F. N. Thiessen. 1993. Ecosection summaries for the Kootenay-Boundary Region. Tech. Rept. TR-003, B.C. Min. For., Forest Sciences and Recreation Sections, Nelson, B.C.

SAS Institute Inc. 1988a. SAS® procedures guide, release 6.03 edition. Cary, N.C.

SAS Institute Inc. 1988b. SAS/STAT™ user's guide, release 6.03 edition. Cary, N.C.

SAS Institute Inc. 1988c. SAS/GRAPH® user's guide, release 6.03 edition. Cary, N.C.

Schmidt, W. C. and R. C. Shearer. 1990. *Larix occidentalis* Nutt. Western larch. *In* Silvics of North America. Volume 1. Conifers. R. M. Burns and B. H. Honkala

(technical co-ordinators). U.S. Dep. Agric. For. Serv., Agric. Handb. No. 654. pp. 160-72.

Spies, T. A. 1990. Current knowledge of old growth in the Douglas-fir region of western North America. *In* Proc. of the XIX IUFRO World Congress held 5-11, August 1990 at Montreal, Canada. pp.116-27.

Steeger, C. and M. M. Machmer. 1995. Wildlife trees and their use by cavity nesters in selected stands in the NFR. Tech. Rept. TR-010, B.C. Min. For., Forest Sciences Section, Nelson, B.C.

Steeger, C., M. Machmer, and P. Fields. 1995. Methodology for establishing wildlife tree patches in operational forests of the NFR. In press.

Steventon, J. D. 1994. Biodiversity and forest management in the Prince Rupert Forest Region: a discussion paper. Res. Branch, Land Man. Rept. No. 82. Victoria, B.C.

Tesch, S. D. 1981. Comparative stand development in an old-growth Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) forest in western Montana. Can. J. For. Res. 11:82-89.

Thomas, J. W., R. G. Anderson, C. Maser, and E. L. Bull. 1979. Snags. *In* Wildlife habitats in managed forests—the Blue Mountains of Oregon and Washington. J. W. Thomas (technical editor). U.S. Dep. Agric. For. Serv., Agric. Handb. No. 553. Portland, Oregon. pp. 60-77.

Turner, D. P. and E. H. Franz. 1985. Size, class structure and tree dispersion patterns in old-growth cedar-hemlock forests of the northern Rocky Mountains (USA). Oecologia (Berlin) 68:52-56.

Utzig, G. Personal communication, July 1993.

Veblen, T. T. 1986. Treefalls and the coexistence of conifers in subalpine forests in the central Rockies. Ecology 67:644-49.

Williams, C., B. Smith, R. Mrowka, J. Berube, and B. Kovalchik. 1992a. Interim old growth definition for subalpine fir series. U.S. Dep. Agric. For. Serv., Region 6. Draft publicati/ n.

———1992b. Interim old growth definition for interior Douglas-fir series. U.S. Dep. Agric. For. Serv., Region 6. Draft publication.